The use of comprehension strategies by good and poor learners: A longitudinal study

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Abstract

This thesis investigates whether comprehension strategy use, motivation, metacognition, representation and prior knowledge can distinguish good from poor learners.

A think aloud experiment examines the strategy use of good and poor learners who were identified by final examination scores. It was found that good learners outperformed poor learners with the number and range of strategies used; the number of inferences generated; and attempts to overcome comprehension failure of unfamiliar material.

A second study examines different components of motivation. The central finding was that students with intrinsic goal orientations and high task value were more likely to achieve academic success. A third study examines metacognitive knowledge of strategies and found that good learners reported using memorisation strategies more frequently than poor learners; while both groups reported less frequent use of understanding and critical thinking strategies. This was interpreted in terms of good learners having greater explicit metacognitive awareness of low-level - but not high-level strategies. A fourth study compares reported strategy use with observed strategy use. High consistency between reported and observed strategy use was only found with the low-level re-reading strategy. Taken together, these findings suggest that both groups of students have some metacognitive awareness of the strategies they use; however, they appear overly optimistic about their use of many reading strategies; and accurately pessimistic about their infrequent use of critical thinking strategies.

A fifth study examines whether representation and prior knowledge distinguishes good from poor learners and found that good learners produced more global ideas when writing summaries and answered more inference questions correctly on unfamiliar material. These findings suggest that good learners were more likely to construct situation models of the text than poor learners.

Two main themes run throughout the work; characteristics that differentiate good from poor learners; and characteristics that seem general to all learners.

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Declaration

The material contained in this thesis has not previously been submitted for any degree.

1.1 Aims of the research

The context of this thesis is **academic learning** which concerns both the **acquisition** and **use** of academic knowledge (Laurillard, 1993). The aim is to investigate the strategies students use in the acquisition and use of such knowledge. The specific focus is on **learning through reading** as the methodology used involves students reading expository texts. Learning is affected by the number (e.g. Loranger, 1994) and type of strategies used (e.g. Fischer & Mandl, 1984); the amount of study experience (e.g. Watkins & Hattie, 1981); motivation (e.g. Weinstein, 1987); metacognitive skills (e.g. Forrest-Pressley & Waller, 1984); prior knowledge and the generation of inferences (Kintsch, Welsh, Schmalhofer and Zimny, 1990) and type of representation constructed when reading (Commander & Stanwick, 1997; McNamara, Kintsch, Songer & Kintsch, 1996). The experiments in this thesis are concerned with the effects of these factors on learning, in particular the differential effects on good and poor learners.

Section 1.2 considers the problems of finding a good measure of learning. For example, the measure of learning, the demands of the learning task, and the materials used all effect the learning outcome (Anderson & Armbruster, 1984). Evidence from studies using **self-report** measures of learning (e.g. Lan, 1996); **performance** measures of learning (e.g. Fischer & Mandl, 1984; Spring, 1985; Commander & Stanwick, 1997); and **both self-report and performance** measures of learning (e.g. Dickinson, O'Connell & Dunn (1996) is evaluated.

Section 1.3 considers whether learning ability influences **strategy use** and reviews the evidence that good learners use **more** strategies (e.g. Loranger, 1994); and/or **different** strategies (Baker, 1985) compared to poor learners. **Section 1.4** considers the effects of **study experience**. Whether students use more effective strategies as they gain experience, or continue to use familiar tried and tested strategies is still unclear as few studies have examined this question directly.

Section 1.5 considers **motivation.** Motivation has been defined as the motives - or reasons - that drive students to learn and that affect the *"initiation, direction, intensity and persistence of behaviour"* (Pintrich, Smith, Garcia, & McKeachie; 1991) Motivation is particularly important in an academic context "*because it* (learning) *is frequently performed in situations when and where alternative activities are somewhat more alluring*" (Thomas & Rohwer, 1986). The next two sections review the role of **metacognition** in learning. Metacognition concerns the ability to reflect on one's thoughts while reading and on the basis of this self-reflection decide what strategies would be appropriate. Two aspects of metacognition are considered; explicit metacognitive knowledge of strategies and self-regulation of strategy use. **Section 1.6** reviews evidence that students with metacognitive knowledge of strategies are better readers (e.g. Spring (1985)); while **section 1.7** considers the finding that good learners self-regulate their learning more effectively than poor learners (e.g. Fischer & Mandl, 1985).

The relationship between *knowledge* of strategies and *use* of strategies is not clear. For example, comparative studies of reported vs. observed strategy use have concluded no relationship (Phifer & Glover, 1982) as well as a significant relationship (Alexander, 1986). **Section 1.8** discusses this relationship by comparing the strategies students report using with the strategies they were observed to use.

The effects of **representation, prior knowledge and inference** on reading are discussed in **section 1.9** and interpreted in terms of Kintsch's (1988; 1992) model of reading comprehension. The research indicates that learning ability affects the type of representation constructed when reading. For example, poor learners are more likely to focus on textual details at the cost of understanding the main ideas while good learners are more likely to focus on the main ideas (Commander & Stanwick, 1997). Evidence also suggests that prior knowledge can facilitate reading. For example, Chi (1978) found that domain specific knowledge can compensate for the memory deficits of children; Schneider, Korkel & Weinert (1986) found that domain specific knowledge can compensate for low aptitude; and Gaultney (1995) found that domain specific knowledge can facilitate the acquisition of a reading comprehension strategy. Prior knowledge has also been found to effect to type of inference generated when reading. More knowledgeable readers are more likely to make inferences based on their background knowledge than less knowledgeable readers (Kintsch, Schmalhofer & Zimny, 1990). **Section 1.10** attempts to tie up the threads of the previous sections and relate them to the present research. In this review, therefore, I evaluate 5 possible characteristics that could distinguish good from poor learners: strategy use; study experience; motivation; metacognition; and prior knowledge.

1.2 Measures of student learning

Measures of student learning include **self-report measures,** such as the use of questionnaires, and **performance measures** such as exam scores. Evidence from studies using these measures of learning are summarised in Table 1.1 on pages 9 - 11. The self-report measures shown in Table 1.1 include reported strategy use, aptitude, expectancy for success and need for cognition. Self-report studies offer useful insights about students' perceptions of themselves as learners and about their perceived study habits. For example, students required to monitor their own learning reported using self-evaluation, rehearsal, memorisation and reviewing strategies more frequently than students required to monitor the effectiveness of their teacher (Lan, 1996). However, one problem with self-report inventories is that they

Table 1.1 Studies of student learning

Author	Method of study	Measures of learning ability	Findings
(1) Self-reported measures of learning			
Lan (1996)	students were allocated to 3 groups (a) monitored own learning; (b) monitored the teacher's effectiveness; or (c) no monitoring	undergraduates recorded the time and frequency spent reading textbooks, completing assignments, being tutored and using other techniques	self monitoring group (a) outperformed the other groups on course texts; (b) reported using more self-evaluation, rehearsal / memorisation, and reviewing strategies
(2a) Performance measures of learning; SAT's, Nelson Denny Reading Tests, Grade Point Averages			
Baker (1985)	college students read passages underlining anything problematic	SAT verbal scores identified high and low verbal ability groups	(a) higher verbal students used more different standards to evaluate comprehension; (b) higher verbal students more likely to notice inconsistencies in texts
Spring (1985)	college students given Spring's questionnaire [1] on study versus comprehension strategies	SAT verbal scores identified good and poor readers	good readers reported using more understanding strategies than poor readers
Hulick & Higginson (1989)	college freshmen given the LASSI questionnaire [2]	GPA's	(a) positive relationship found between reported strategy use and GPA's; (b) students with low LASSI scores for time management, anxiety, and attitude reported that they found college difficult
Loranger (1994)	11th grade students were videotaped while reading for use of notetaking, summarizing and outlining	Nelson Denny reading test; GPA's; and and teacher recommendations identified successful and unsuccessful students	successful students used more study strategies than unsuccessful students;
Albaili (1997)	undergraduates (United Arab Emirates) given the LASSI questionnaire	GPA's used to identify low, average and high achieving groups	(a) LASSI motivation scale was the most powerful discriminating factor between low and high achievers; (b) low achievers had lower scores for all LASSI scales compared to high and average achievers

1 Spring (1985). Reading Strategies Questionnaire.
2 Weinstein, Palmer & Schulte (1987). The Learning and Study Strategies Inventory (LASSI).

Table 1.1 Studies of student learning - continued

Author	Method of study	Measures of learning ability	Findings
Commander & Stanwick (1997)	undergraduate and graduate students read short and long texts; gave confidence ratings; and answered MCQ's and free recall tests	Nelson-Denny reading test identified good and poor readers	(a) good readers recalled more main ideas while poor readers recalled more details; (b) good monitors had better free recall than poor monitors
(2b) Performance measures of learning; exams, reading comprehension measures (e.g. MCQ's)			
Nist, Simpson, Olejnik & Mealey (1991)	university freshmen enrolled on a study methods course read different texts and strategy use was assessed in relation to four study processes: encoding; word meaning; organizing; and controlling	test performance (MCQ's, true-false questions and essay questions)	executive control processes had the highest correlation with (a) test performance (preplanning tasks and goals; (b) listing most appropriate strategies for the task; (c) activating the plan and monitoring the plan's progress so fix-up actions can be used if plan ineffective
Chi, Leeuw, Chiu, & LaVancher (1994)	8th grade students either generated explanations (explainers) when reading or read the text twice (control group)	prior knowledge of circulatory system tested before and after reading the text; high and low explainers identified from number of self-explanations	(a) self-explainers had higher gains in circulatory knowledge tests from pretests to posttests than control group; (b) high explainers answered more complex questions than low explainers
Sinkavich (1994)	college students given questionnaires measuring (a) motivation, information processing and self-testing (LASSI); and (b) attributional style (ASQ) [3] and (c) measures of metamemory (from confidence ratings of exam MCQ's)	exam performance (MCQ's)	(a) exam performance correlated moderately with use of metamemory and motivation; (b) use of metamemory, motivation and attributional style comprised the best set of predictors for exam performance
Fischer & Mandl (1984)	undergraduates prepared for free recall tests and MCQ's after reading; plus retrospective interviews	reading performance measures and reading times identified good and poor readers	(a) good readers focused on planning and scheduling of learning while poor readers focused on text details; (b) good readers focused on regulative aspects of text processing while poor readers focused on self-related aspects of themselves and failure oriented monitoring of current progress

3 Peterson, Semmel, von Baeyer, Abramson & Seligman (1982). Attributional Style Questionnaire (ASQ).

Table 1.1 Studies of student learning - continued

Author	Method of study	Measures of learning ability	Findings
Nist, Mealey, Simpson & Croc (1990)	college students given LASSI questionnaire before and after a study skills course; GPA's	regularly admitted (RAS) vs developmental studies students (DSS) [4]	(a) growth found with RAS on all LASSI scales; (b) growth found with DSS on all scales except motivation and attitude; (c) LASSI predicted GPA's of RAS but not of DSS
Ickes & Fraas (1990)	College students given the LASSI questionnaire during a study skills course	developmental studies students	(a) progress found with anxiety, time management, concentration, information processing, self-testing and study aid scores; (b) LASSI did not predict academic performance
(2c) Performance measures of learning: problem solving			
Chi, Bassok, Lewis, Reimann & Glaser (1989)	2 postgraduates and 8 undergraduates (none had taken a college physics course) solved physics problems	good and poor students identified from problem solving successes with isomorphic and chapter problems	(a) good students' generated self-explanations which refined and expanded the conditions for action of problems and accurately monitored understanding; (b) poor students had fewer self-explanations, monitored understanding less accurately, and relied heavily on examples
(3) Both self report and exam performance measures of learning			
McKeachie, Pintrich & Lin (1985)	compared students attending and not attending a study strategies course	all students were given questionnaires on locus of control and expectancy for success [5]; need for cognition [6]; anxiety [7]; and the LASSI. Also used GPA's	(a) subjects on study strategies course made positive gains on all measures compared to non-attenders; (b) positive correlation found between LASSI scores reported after the study strategies course and later GPA's
Dickinson, O'Connell & Dunn (1996)	undergraduates recorded the dates and times of each study period; coded each study episode as a reading, reviewing or organising activity	aptitude (measured by ACT [8] questionnaire); distributed study time (from the number of study episodes) within a period of study). Also given factual and conceptual MCQ's; essay exams and objective exams	(a) distributed study time related to conceptual MCQ's and essay scores - but not factual MCQ's; (b) aptitude related to factual and conceptual MCQ's, essay and test scores; (c) high scorers spent less time on study but had more episodes of study (i.e. distributed their study time more effectively)

4 Regularly admitted students (RAS) were considered to have the necessary study skills whereas developmental studies students (DSS) were considered to have weak study skills and were required to attend a study skills course
5 A non-specified measure of attributions and expectancies for success and failure
6 Cacioppo & Petty (1982. A measure of need for cognition.
7 An unspecified 5 item test of anxiety.
8 Aptitude questionnaire (ACT). Not referenced by Dickinson et al (1996).

usually ask students to generalize across different situations and different courses (Rohwer, 1985). The performance measures shown in Table 1.1 include verbal SAT scores, Nelson Denny reading test scores, grade point averages, free recall tests, multiple choice questions, true/false questions, essay tests, and exam scores. Studies using performance measures of learning have increased our understanding of the differences between students who perform well on these measures from students who do not. For example, students who perform well have been found to be more proficient at self-regulating their reading (Fischer & Mandl, 1984); noticing inconsistencies in texts (Baker, 1885); and monitoring their comprehension more accurately (Chi et al, 1989). However, the demands of the performance task and the nature of the materials used both effect the learning outcome. For example, taking notes has been found to more effective, equally effective, or less effective than other strategies, depending on the nature of the task and the materials used (Anderson & Armbruster, 1984).

The studies shown in Table 1.1 suggest that a small number of studies use self-report measures, while most studies use performance measures or a combination of performance and self-report measures. The problem though, is that different performance measures may tap different kinds of learning. In principle, a good measure of learning should get at the strategies students use to **understand** material when reading. However, in practice such a measure is difficult to obtain. Given the distinction that Stevenson & Palmer (1994) make between memorisation and learning (and that Spring (1985) makes between study strategies and comprehension strategies) the outcome of simple comprehension tests (like verbal SAT scores and Nelson Denny reading tests) and simple performance tests (like free recall, true/false questions or multiple choice questions) are unlikely to tap understanding. What is needed is a test that gives an estimate of **long term learning** rather than one that measures **immediate performance**. Schmidt & Bjork stress this need eloquently. They claim that learning should be measured by performance on longer term retention tests, rather than immediate tests of performance at the acquisition stage because "*measures of learning during the acquisition stage are "flawed, or at least ambiguous with respect to the amount learned*" (1992, p 209). The main problem is that factors which enhance immediate performance in practice can also degrade performance on tests of long term retention or transfer. For example, giving frequent feedback during training can enhance performance while training, but may degrade performance at retention. One explanation for this is that frequent feedback may hinder the use of error detecting skills that enhance long term learning. Similarly, factors that degrade performance in training can enhance longer term retention performance. For example, increasing task variability during practice degrades performance in training, but can enhance performance at retention as varying the practice contexts encourages the learner to think about lawful relationships of the varying tasks. Schmidt & Bjork argue that the effectiveness of learning is revealed by the level of retention rather than the level of acquisition. Thus, with reference to the measures indicated in Table 1.1, exam scores should give a better estimate of long term learning than SAT scores or multiple choice questions because, in general, the exam is not administered immediately after learning. An alternative measure of learning was used by Chi, Leeuw, Chiu & LaVancher (1994). They tested prior knowledge before and after reading texts and found that students who generated self-explanations while reading had higher pre to post tests gains. However, their test was still an immediate test of learning so there is no guarantee that the findings would hold up in the long term.

With the aim of getting a measure of long term as opposed to immediate learning, I decided to use essay exam scores as a measure of learning ability. Dickinson et al (1996) found essay exam scores correlated with the time spent reading and studying, the number of study episodes and students' aptitude scores. In contrast, factual exams, conceptual exams and objective exams correlated only with aptitude scores. Nist et al (1990) also used essay scores, but included multiple choice and true/false questions to get an overall mean test score, and therefore did not consider whether different tests had different effects on the outcome. The remaining studies in Table 1.1 used true/false questions, free recall tests, multiple choice questions, or course grade scores as measures of test performance.

The essay exam scores used in this study were the median scores of either 9 exams (for non-psychology students) or 12 exams (for psychology students). Exams were taken at the end of the second and third years. Each exam consisted of answering 3 or 4 essay questions relating to topics studied during that academic year. From these scores a group of "*good*" and a group of "*poor*" performers were identified. However, as this was a longitudinal study, we needed to select a sample of students in their first year at university, and therefore used the Learning and Study Strategies Inventory (or LASSI - Weinstein, 1987) to identify an initial group of "*good*" and a group of "*poor*" learners. Exam performance may not be a pure measure of understanding, because it is possible to pass an essay exam with a fairly superficial understanding of the material if the questions are predictable. However, it does seem to be the best measure available.

The LASSI (Weinstein, Zimmerman & Palmer, 1988) is a self-report learning inventory which measures the use of learning and study strategies across 10 learning subscales; Attitude, Motivation, Time Management, Anxiety, Concentration, Information Processing, Selecting Main Ideas, Study Aids, Self Testing and Test Strategies. The *Attitude* scale measures students' general attitudes toward school and their general desire to succeed and complete school related tasks. The *Motivation* scale measures students' ability to take responsibility for their own learning. The *Time management* scale measures how well students cope with demands on their time. A low score on the *Anxiety* scale implies high anxiety, and reflects negative thoughts about one's ability, intelligence and future success. The *Concentration* scale measures how well students can focus and pay attention in a learning situation. The *Information Processing* scale measures how well students "*can create imaginal and verbal* *elaborations and organisations to foster understanding and recall.*" (Weinstein, 1987). The *Select Main Ideas* scale measures the ability to pick out the main ideas from supporting detail. The *Study Aids* scale measures how successful students are at using "*hints*" or "*cues*", such as headings, special type, summaries and statements of objectives. The *Self-Testing* scale reflects the ability to review material and test one's understanding. Finally the *Test Strategies* scale relates to both test preparation and test performance. Some examples of statements are shown below:

I feel confused and undecided as to what my educational goals should be.
I work hard to get a good grade, even when I don't like a course.
I make good use of daytime study hours between classes.
I am very tense when I study.
When I begin an examination, I feel pretty confident that I will do well.

Test-retest correlation coefficients show that the scale scores have a high degree of stability ranging from .64 (selecting main ideas) to .81 (anxiety). The validity of the LASSI however, has been criticised for citing brief and vague data (Mealey, 1988). The authors cite only 2 validity statistics: information processing scores correlated with the Elaborative Processing Scale of Schmeck's (1977) Inventory of Learning Processes ($r = .60$); and selecting main ideas scores correlated with students' scores from selecting main ideas from texts ($r = 0.40$ and above). Weinstein also claims "*user validity*" from various professors, advisors and educationalists who used the LASSI on a trial basis, although this is questionable as evidence of validity (Mealey, 1988). However, Table 1.1 shows that Albaili (1997); Sinkavich (1994); Ickes et al (1990); Nist et al (1990); and McKeachie et al (1985) all found the LASSI did discriminate between regularly admitted good and poor students; but not with "at risk" students who attended study skills courses because they were considered to have weak study methods. As the subjects in this present study had no special reading or study needs the LASSI was considered a suitable measure of reported learning ability, and was used to identify a group of "good" and a group of "poor" learners.

In essence, the LASSI was used to select initial groups of good and poor learners. This measure was subsequently replaced by a learning measure based on exam performance and the assignment of subjects to the good and poor learning groups was adjusted accordingly. Once the measure of learning ability had been selected, the next step was to consider the types of strategies students typically use when reading.

1.3 Reading strategy use

Reading strategies are tactics that readers use to help them understand and learn while reading. Some strategies enhance understanding whereas others achieve short-term gains such as remembering rather than genuine learning. Some researchers use the terms comprehension and study strategies (e.g. Spring, 1985) to make this distinction; others use deep and surface level strategies (e.g. Schmeck, Ribich & Ramanaiah, 1977); while others prefer high-level and low-level strategies (Stevenson & Palmer, 1994). Some researchers suggest a third group of "*elaborative*" strategies that fall midway between the two extremes (Schmeck et al, 1977; Weinstein et al, 1987). I will use the terms high-level and low-level strategies for the sake of clarity. Although the terminology differs there appears to be general agreement that high-level strategies promote understanding while low-level strategies lead to remembering.

High-level reading strategies tend to be used by adults rather than children. Examples are evaluating new textual information and prior knowledge with respect to each other. These strategies involve evaluating and updating one's interpretation of the text, and enhance learning more successfully than the simple accumulation of new facts (Stevenson & Palmer, 1994). Identifying important information and looking for logical relationships when reading are also high-level strategies (Spring, 1985). Reading material critically by relating it to one's beliefs, emotions and experiences are also considered to be high-level strategies, although university students have been found to use them infrequently (Spring, 1985). High-level strategies also include metacognitive strategies such as planning a task, monitoring the success of a strategy, and regulating comprehension by using "*fix-up*" strategies when comprehension failure arises (Nist et al, 1991). Schmeck's (1977) Inventory of Learning Processes was used by several of the studies in Table 1.1. Schmeck developed a "*synthesis-analysis*" scale to measure a deep approach to learning. High-level strategies characteristic of this scale included evaluation and comparing and contrasting examples across domains. Both Schmeck and Weinstein included organisation strategies (such as creating conceptual maps) as high level strategies, since they transform information by imposing organisation on unordered content. This is an active process which enhances understanding.

Low-level reading strategies are used by children and adults, although with adults, they tend to aid memorisation rather then understanding. For example, linking text to prior knowledge is not a high-level strategy if used by adults, but could be considered a high-level strategy if used by children (Stevenson & Palmer, 1994). Children find it difficult to appreciate the benefits of employing understanding strategies over memorization strategies (Lovett & Flavell, 1990). Schmeck's (1977) study methods scale describes how a focus on details and fact retention led to a literal verbatim memory of to-be-learned information. Spring (1985) identified the following as low-level strategies: re-reading, underlining, self-testing, restatement (or paraphrasing), taking notes, outlining, summarising, and drawing diagrams.

The third group of strategies, called elaborative strategies have been defined in different ways. Schmeck (1977) defines them as characteristic of students who like to "*personalise*" their learning and develop personal growth. Examples are mental imagery strategies such as visualising and summarising. Weinstein (1977) defines elaborative strategies as "*adding some symbolic construction to the to-be-learned material*". For example, linking new material with what is stored in memory organises the new information more effectively, and thus enhances understanding. According to Weinstein paraphrasing, summarising, creating analogies, and using previous experience are all elaborative strategies.

The problem of trying to put strategies into distinct groups has beset many researchers, and arises because the processes involved in understanding and remembering overlap. To Weinstein, summarising and paraphrasing are elaborative strategies while to Spring, they are low-level strategies. Also linking text to prior knowledge has been classed as a high-level strategy (Spring, 1985) and an elaborative strategy (Weinstein, 1987). Stevenson & Palmer (1994) however, distinguish between using prior knowledge to understand and to remember. If new information has only been superficially integrated with prior knowledge then understanding will also be superficial. For understanding to occur a two-way process of evaluation is needed: "*prior knowledge is needed to assess the understanding of new material .... and prior knowledge is assessed, updated and revised in light of the new material*" (Stevenson & Palmer, 1994; Scardamalia & Bereiter, 1991).

As this study concerns university students, of particular interest is strategy use in an academic context. Simpson (1984) found that college freshmen (first year undergraduates) used a restricted range of study strategies, often using the same single strategy for most learning tasks. The students relied heavily on low-level underlining and re-reading strategies, and frequently failed to use the higher-level cognitive monitoring strategies of planning, checking, evaluating and regulating their performance. On a more positive note, after taking part in training programs, students have been found to employ a wider variety of strategies (Nist et al, 1991) and carry out a study task more effectively if they have experienced that task before, have previously used a strategy to complete that task, and have practiced and received feedback on the successful employment of that strategy (Pressley, Forrest-Pressley, Elliott-Faust & Miller, 1985).

All in all, the implications of the evidence on strategy use for predicting the outcome of the present study are unclear. On the one hand good students are thought to use high level strategies more frequently than poor students. On the other hand college students have been found to use a severely restricted range of strategies. My tentative prediction is that more able students will use high level strategies more frequently than less able students, but that the strategy use of both groups may be too small to produce a significant difference.

1.4 Effects of educational experience on use of reading strategies

There's been relatively little study of how strategy use may change as a result of greater educational experience. For example, do students use the same tried and tested strategies

Author	Method of study	Measures of learning ability	Findings
Goldston, Zimmerman, Seni & Gadzella (1977)	college students given Brown & Holtzman's survey of study habits and attitudes questionnaire [9]	survey given at 3 different times during one semester	downward shifts of some study habit skills
Seni, Gadzella & Goldston (1978)	college students given survey of study habits and attitudes	survey given at 3 different times during one semester	upward trends for students exposed to effective study habits and downward trends for students not exposed to them
Watkins & Hattie (1981)	first year (Australian) undergraduates given *questionnaires* : Biggs' SPQ [10] and Schmeck's ILP	year of study	the more years of university study - the more likely students used deep approaches to study
Bartling, C. A. (1988)	college students given Bartling's (1987) ILP-SF [11] questionnaire	questionnaire given prior to the first semester and during the fourth semester	after 2 years of study students were less likely to report using systematic study methods than when they started college; and were more likely to report using deep approaches to study
Jacoubeck & Swenson (1993)	undergraduates given Schmeck's Inventory of Learning Processes questionnaire measuring reported use of deep, elaborative, and fact retention strategies; course grades	year of college (freshmen, sophomore, junior or senior)	reported differences found with: deep processing strategies (freshmen vs. sophomore); and elaborative processing strategies (freshmen vs. senior); no differences found with fact retention; questionnaire scores did not predict course grades

Table 1.2 Longitudinal studies of student learning.

9 Brown, W.F. & Holtzman, W.H. (1966). Survey of study habits and attitudes.
10 Biggs, J.B. (1979) The Study Process Questionnaire (SPQ).
11 Bartling, C.A. (1987) Shortened form of the Inventory of Learning Processes. (ILP-SF).

during their 3 years at university, or do they use more efficient strategies as they gain more experience? There have been few longitudinal studies monitoring the changing nature of strategy use with study experience. Evidence from such studies is shown in Table 1.2. Research tends to be either longitudinal over one or more semesters, e.g. Goldston, Zimmerman, Seni & Gadzella (1977); Seni, Gadzella & Goldston (1978); or cross-sectional, comparing different students in different years of study, e.g. Watkins & Hattie (1981); Bartling, (1988); Jacoubeck & Swenson (1993). The main findings are that an increase in study experience is accompanied by a decrease in the use of study habits (i.e. low level strategies) and an increase in the use of deep approaches to study (i.e. high level strategies). Watkins & Hattie (1981) suggest that progression towards using deep approaches to study with experience may be due to socialization processes (e.g. students are exposed to different study contexts in different departments); and also to changing academic demands from the first to the final year of study. Bartling (1988) found that students who completed four semesters of study were more likely to report using "deep level" approaches to study. Furthermore, correlations between Inventory of Learning Processes (ILP) scores and grade point average scores were higher after 4 semesters, than correlations with ILP scores measured just before the first semester. Thus postdictive validities of the ILP were higher than predictive validities. Bartling concluded *"that students' perceptions of their learning and study habits are more closely dependent upon their current and past academic performances than are their academic performances dependent upon (reported) learning and study habits"* (1988, p 533). This has worrying implications for the use of learning inventories that measure study behaviour because students' self-reports may reflect little more than feedback from past academic performances. I consider these implications in more detail in the next chapter (section 2.5).

Overall, therefore, the evidence suggests that as students gain more study experience, they will use high level study strategies more frequently and use low level study strategies less frequently. Two further research areas - although not directly comparable to this study - have investigated aspects of educational experience which are pertinent to a consideration of the role of educational experience. These are expert-novice studies; and studies of developmental differences.

Expert - Novice differences Comparisons of experts and novices reading texts may shed some light on changes that may occur in the strategy use of students as they become more experienced. Evidence from studies investigating the strategy use of experts and novices is summarised in Table 1.3 shown overleaf.

Author	Experts	Novices	Task	Findings
Bereiter & Bird (1985)	2 graduate students & 8 adults from a variety of middle class occupations	NONE	analysed protocols from experts thinking aloud while reading 6 different types of prose	identified 4 main strategies for dealing effectively with comprehension difficulties: restatement; backtracking; demanding (to see) relationships; and problem formation
Afflerbach (1986)	2 graduate students reading texts from within own discipline	2 graduate students reading texts from outside own discipline	analysed verbal reports of experts and novices reading both types of text	specific cues selected varied with domain familiarity: experts used a variety of cues to determine what was important including contextual knowledge based cues; text structure cues and cues provided by the author
Lundeberg (1987)	law professors and practising lawyers	proficient readers with at least a masters degree but no experience in law	analysed verbal reports using a modified think aloud procedure as subjects read a legal case	identified 6 general strategies used more frequently by legal experts: using context; overviewing; re-reading analytically; underlining; synthesising and evaluating. Legal novices expressed confusion with legal terms
Schneider, Korkel & Weinert (1989)	3rd, 5th & 7th grade children with expert soccer knowledge	3rd, 5th & 7th grade children with novice soccer knowledge	verbal aptitude tests used to identify high and low aptitude experts and novices. Measures of memory performance and text comprehension were analysed	Low aptitude experts outperformed high aptitude novices on all memory and comprehension measures indicating domain-specific knowledge can compensate for low aptitude on related cognitive tasks

Table 1.3 **Studies of experts and novices.**

Table 1.3 Studies of experts and novices - continued.

Author	Experts	Novices	Task	Findings
Tardieu, Ehrlich & Gyselinck (1992)	20 postgraduates : (experts in the domain of memory but novices in the domain of physics	20 undergraduates (novices in the domains of memory and physics)	Both groups read text on memory and text on physics and answered paraphrase and inference questions	With the memory text: experts were faster than novices with inferences; no difference between the 2 groups with paraphrases. With the physics text: no difference between the 2 groups for both measures.
Schraagen (1993)	**design experts** (had at least 10 years experience designing experiments in psy-chology); **domain experts** (had at least 10 years experience designing experiments in sensory perception)	**beginners** (undergrads who had designed 1 or 2 experiments); **intermediates** (grad-uates who had designed 3 or 4 experiment - but not in domain of sensory perception)	subjects had to design an experiment in familiar and unfamiliar areas	quality of solutions of design experts was lower than that of domain experts; design experts used more design principles than domain experts; when experts were confronted with novel problems their form of reasoning was intact, but the content of their reasoning suffered due to a lack of knowledge
Gaultney (1995)	10 year old boys with expert baseball knowledge	10 year old boys without expert baseball knowledge	boys were trained to ask "*why*" questions when reading baseball vs. non-baseball stories	strategy use (of why questions) and recall were greater with baseball stories indicating domain specific knowledge aids the acquisition of a reading strategy; accuracy of monitoring was linked to greater strategy use

The studies in Table 1.3 suggest that experts, compared to novices, use the following strategies to overcome comprehension failure; restating the text in more familiar terms; re-reading difficult sections; set up "*watchers*" to look for specific information; and identifying difficulties as problems (Bereiter et al, 1985). Experts also used cues from the context, from the structure of the text and from the author to determine important points (Afflerbach, 1986). When reading legal cases, legal experts were more likely to overview a case, re-read analytically, and try to summarise and evaluate a case (Lundeberg, 1987). Furthermore, domain specific knowledge was found to overcome low aptitude (Schneider, Korkel & Weinert, 1989); enhance the quality of solutions to problems (Schraggen, 1993); be linked to greater strategy use, greater recall, and more accurate monitoring (Gaultney, 1995); and foster the generation of inferences but not paraphrases (Tardieu, Ehrlich & Gyselinck, 1992).

However, there are several problems with the above studies. First, most studies of expertise are cross-sectional, i.e. they compare experts with novices, so changes in the same individuals with *increasing* expertise are not directly measured. Furthermore, not only do the experts have more experience, in most studies they are also older. This latter problem is difficult to avoid. For example, Anderson's theory of expertise (1983) predicts reading to be a function of practice, so those who have been reading longer should be more expert readers. Similarly, Chall's model of reading development (1979, 1983) describes the transition to the highest stage of reading as probably occurring at college or graduate level, but that this stage does not occur exclusively in formal education, nor does it occur in every individual. Chall (1983) states the highest stage is acquired by "*wide reading of ever more difficult materials, reading beyond ones immediate needs ... that calls for the integration of varied knowledge and points of view*". Only three of the studies in Table 1.3 did not confound age with expertise: Gaultney (1995); Schneider et al (1989) and Afflerbach (1986) compared students reading from within and outside their domain of expertise and thus held age constant. Thus you may feel more confident that the results of these studies reflect expertise rather than experience.

Another problem with studies of expertise is that the experience needed to warrant expert status is not clearly defined. Graduate students are frequently classed as experts in such studies, however, it is unlikely that they will become "experts" after 3 years of undergraduate study. According to Ericsson, Krampe & Tesch-Romer "*expert performance is acquired slowly over a very long time as a result of practice and that the highest levels of performance and achievement appear to require at least 10 years of intense prior preparation*" (1993, p 366). Simon & Chase (1973) observed that no chess player attained international status (i.e. grandmaster) with less than a decade's preparation time. Furthermore, J.R. Hayes (1981) claimed 10 years' experience was necessary for musical composition, with an average of 20 years elapsing from first starting to study music and first composing an outstanding piece of music. In a review of the preparation time needed for attainment of exceptional performance, Ericsson & colleagues cited support for the "10 year rule" from domains including mathematics

(Gustin, 1985); tennis (Monsaas, 1985); and swimming (Kalinowski, 1985). Long periods of preparation are also needed for scientists and writers, with on average 10 years elapsing between the scientists' and authors' first work and their best work (Raskin (1936); cited in Ericsson, Krampe & Tesch-Romer (1993)). Of the studies listed in table 1.3, only Shraagen (1993) considered expertise in terms of experience; so most of the experts identified in Table 1.3 would not be considered experts using the "10 year rule".

Despite these problems research on expert-novice differences may shed some light on the role of educational experience on efficient strategy use. With the ill defined nature of expertise in mind, Pressley & Afflerbach (1995) summarized the literature comparing expert and novice readers. They concluded that better and more experienced readers (i.e. more experienced with the domain of the text to be read) "*are more capably and certainly constructively responsive than weaker and less experienced readers.*" (p 106). The processes and strategies that Pressley and Afflerbach regard as being constructively responsive are shown in Table 1.4.

1. Overviewing before reading (determining what is there and deciding which parts to process).
2. Looking for important information in text and paying greater attention to it than other information (e.g. adjusting reading speed and concentration depending on the perceived importance of text to reading goals).
3. Attempting to relate important points in text to one another in order to understand the text as a whole.
4. Activating and using prior knowledge to interpret text (generating hypotheses about text, predicting text content).
5. Relating text content to prior knowledge, especially as part of constructing interpretations of text.
6. Reconsidering and/or revising hypotheses about the meaning of text based on text content.
7. Reconsidering and/or revising prior knowledge based on text content.
8. Attempting to determine the meaning of words not understood or recognised, especially when a word seems critical to meaning construction.
9. Using strategies to remember text (underlining, repetition, making notes, visualising, summarising, paraphrasing, self-questioning, etc.).
10. Changing reading strategies when comprehension is perceived not to be proceeding smoothly.
11. Evaluating the qualities of text, with these evaluations in part affecting whether text has impact on reader's knowledge, attitudes, behaviour, and so on.
12. Reflecting on and processing text additionally after a part of text has been read or after a reading is completed (reviewing, questioning, summarising, attempting to interpret, evaluating, considering alternative interpretations and possibly deciding between them, considering how to process the text additionally if there is a feeling it has not been understood as much as it needs to be understood, accepting one's understanding of the text, rejecting one's understanding of a text).
13. Carrying on responsive conversation with the author.
14. Anticipating or planning for the use of knowledge gained from the reading.

Table 1.4 Conscious constructive responses to text (from Pressley & Afflerbach, 1995)

The authors stress these processes and strategies were not designed as a guide to expert-novice differences, but nevertheless seem characteristic of expert readers. The main question for the present study is whether the constructive responses could be classed as high-level strategies. Inspection of Table 1.4 shows that most of the constructive responses appear to enhance understanding rather than remembering, and so could be defined as high-level strategies. Some strategies in items 9 and 12 list strategies for remembering text (underlining, making notes, summarising, paraphrasing and questioning) which have been argued to be more characteristic of poor than good readers (Spring, 1985). However, Pressley & Afflerbach argue that although skilled readers use these strategies to focus on details, the main goal is to keep track of the main ideas. The essential difference seems to be the goal of the reader; poor readers use these strategies to *remember* text while skilled readers use them to enhance their *understanding*.

In the light of the difficulties faced by studies of expert-novice differences, a better approach is to carry out a longitudinal study. Alexander and colleagues argue the case for this succinctly:

> *"Theories of expertise that centre on expert-novice differences ... fail to appreciate the movement towards competence that is probably characteristic of most students' experiences in academic domains ... the progression from acclimation, to competence and perhaps onto expertise is a time-intensive occurrence .... that needs longitudinal investigations .... a multiyear analysis of students' development would bring an even richer perspective of the cognitive and affective changes associated with learning in a domain."* (1997, p 143).

Thus by adopting a longitudinal design in this study, I can overcome some of the limitations of expert-novice studies and investigate the movement towards competence which Alexander et al advocates.

Developmental differences Developmental changes in cognition from early childhood to adolescence and the college years progresses along several dimensions including: memory, thinking and greater cognitive capacity; self-awareness; and metacognitive ability. As children get older they become better at most cognitive tasks. Evidence suggests that from childhood through to college years, strategy use becomes more autonomous, generalised and spontaneous (Pressley, Borkowski & Schneider, 1986). Older children are more able to recognise their monitoring abilities than younger children (Pace, Sherk, Peck & Baldwin, 1985). Also younger and less proficient readers know less and regulate less as they comprehend and think, compared to older and more proficient readers (Garner & Alexander, 1982). Furthermore, younger and poorer readers tend not to use appropriate strategies as they may not know of different possible strategies (linked to metacognitive knowledge which is discussed shortly); they may not know enough about strategies and reading situations to chose the most appropriate for that situation; or they may not monitor their usage and effectiveness (which is linked to metacognitive control discussed shortly) (Forrest-Pressley & Waller, 1983). The overall picture suggests that as development progresses, students learn more about their own cognitive strategies and begin to monitor their performance while using them. Eventually, students begin to plan their learning, check progress at reaching goals, monitor the effectiveness of chosen strategies, and apply different ones if needed. Students, particularly during adolescence, acquire increasingly sophisticated learning strategies and knowledge of the range of their use.

More recent evidence has shown that 10 year old boys trained to use a strategy (asking why questions) demonstrated greater strategy use when reading texts from within rather than outside their domain of expertise. Boys with higher declarative metacognitive knowledge scores also asked more why questions (Gaultney, 1995). Pressley & Ghatala, (1990) concluded that there are developmental improvements from childhood to adulthood, with poor monitoring characteristic or early school years; monitoring is more likely to occur during a test (particularly in later school years) than during study; and monitoring is not perfect, even with adults. Otero & Campanario (1988) also found developmental differences with comprehension monitoring; e.g. younger students identified fewer inconsistencies when reading and showed a higher instance of an illusion of knowing [12] than older students.

However, there are problems with developmental studies. First, as children get older, they also acquire more knowledge about cognition generally, as well as acquiring a more complex knowledge base; thus a confound in developmental studies exists (Folds, Footo, Guttentag & Ornstein, 1990). Also educational experience is not constant as children in different age groups may attend different schools, and are probably taught by different teachers using different teaching methods and objectives.

Even though expert-novice and developmental studies are not directly comparable to this research, the findings support the general view that more experienced people are more likely to use strategies that enhance understanding when reading. Alexander, Murphy, Woods, Duhon & Parker (1997) argue that the use of a longitudinal design will capture the movement towards competence that expert-novice studies overlook. Furthermore, these authors stress that "*a multi-year analysis of students' development would afford us an even richer perspective of the cognitive and affective changes associated with learning in a domain*" (1997, p 143). So by adopting a longitudinal design and a multi-year analysis I hoped to address some of the methodological limitations of previous studies of expert-novice and developmental differences..

1.5 Motivation

Evidence suggests that good learners are more motivated than poor learners. According to Weinstein (1987) a well-motivated student demonstrates a willingness to work hard, has a considerable degree of incentive, is diligent, stays on top of work and is self-disciplined. The implications for this study are that good learners should have higher scores on the motivation scale of the LASSI than poor learners. However, whether motivation increases or decreases as

[12] Illusion of Knowing arises when readers believe they understand the text but subsequent comprehension measures show they do not (Glenberg, Wilkinson & Epstein; 1982).

students become more experienced is not clear. I investigate this question by comparing LASSI motivation scores across three years of study. However, the LASSI motivation scores do not consider different aspects of motivation, such as goal orientation, task value and expectancy for success. To investigate motivation more thoroughly, the Motivated Strategies for Leaning Questionnaire - or MSLQ - (Pintrich, Smith, Garcia & McKeachie, 1991) is used.

Pintrich and colleagues have worked on different research projects over the last 10 years about how to teach college students learning strategies and to improve their motivation. They have developed a *general expectancy-value model* of college student motivation and self-regulated learning upon which the MSLQ is based. This model is shown in Figure 1.1 and illustrates the relationships between 6 general constructs of motivation: student goal orientation; task value; students efficacy, control and outcome beliefs; perceptions of task difficulty and perceived competence; test anxiety and affect; and expectancy for success. These general constructs are "student perception constructs assumed to mediate the relationship between the college classroom environment and student involvement and achievement" (McKeachie, Pintrich, Lin, Smith & Sharma, 1990).

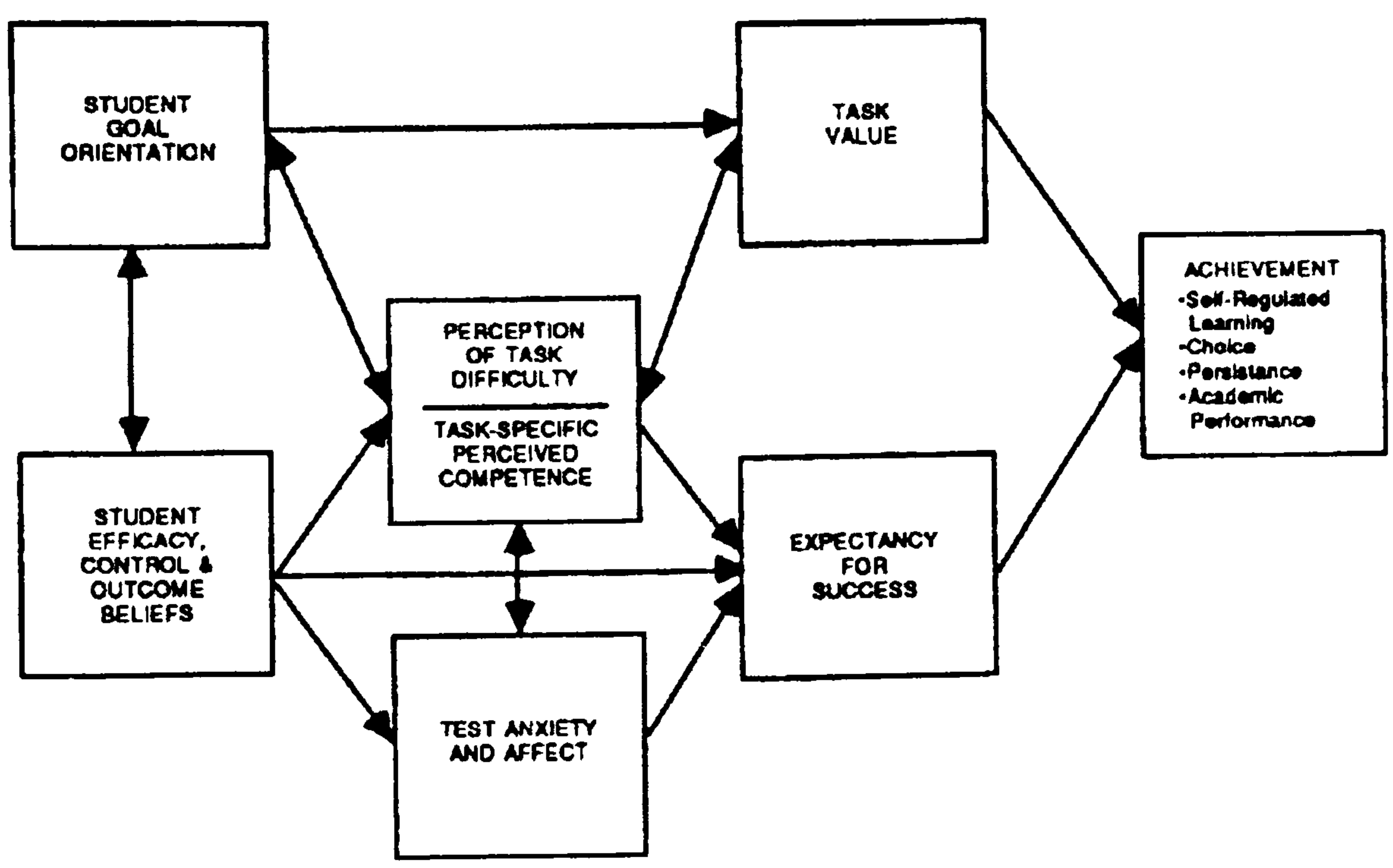

Figure 1.1: Components of motivation (McKeachie, Pintrich, Lin, Smith & Sharma, 1990).

The model contains two main pathways; the expectancy path and the task value path. Of particular interest to this study is the way the components in these pathways affect academic achievement. The **expectancy path** (shown in the lower half of Figure 1.1) reveals that student efficacy, control and outcome beliefs; perceptions of task difficulty and task related self-competence; and anxiety - each affect expectancy for success. Expectancies are defined as "students' beliefs about the probability of success or failure in a particular task"; and can be *specific* (i.e. believe failure in a particular exam is caused by lack of study) or more *general* (i.e. believe they will do poorly in all future college exams). Pintrich et al describes how each component in the expectancy path affects achievement.

The effect of a **student's beliefs about efficacy, control and outcome** on achievement is explained in terms of attribution theory and self-efficacy theory. With attribution theory, the proposition is that students' *causal attributions* mediate future expectations, rather than actual success or failure. For example, a student who attributes success to ability (e.g. I did well because I'm good at that subject) will have high expectations of future success because ability is presumed to be stable. In contrast, a student who attributes success to other factors (e.g. I did well because the exam was easy) will have lower expectations of future success because the "easiness" of an exam is less stable. Pintrich and colleagues describe how the following three main causal dimensions[13] affect achievement: locus-of-control; stability; and controllability.

The *locus* dimension distinguishes internal causes (e.g. ability) from external causes (e.g. task difficulty). Evidence for a positive relationship between perceived control and achievement is not straightforward. Stipek & Weisz (1981) found no relationship with young children (grades 1 - 3) while Findley & Cooper (1983) comment that the relationship between perceived control and achievement was strongest with young adolescents and weakest with children and university students.

The *stability* dimension refers to how stable over time attributes are. For example, ability and effort are both internal causes, but ability is assumed to be more stable than effort. Attributions with stable causes (e.g. ability) have more positive outcomes for future success than less stable causes (e.g. effort). Evidence suggests that people's intuitive beliefs about ability can affect the goals they set themselves when learning. Dweck & Leggett (1985) found that children with an *entity* theory of intelligence (i.e. viewed intelligence as a fixed, unchangeable entity) tended to adopt *performance goals* with the aim of performing well in relation to others. In contrast, children with an *incremental* theory of intelligence tended to adopt *learning goals* with the aim of mastering a challenging task and increasing their competence. Leggett & Dweck (1986) have also shown that the amount of effort given to a task can be related to these goals. When faced with a task requiring a lot of effort, children with performance goals believed the need for great effort reflected their lack of ability; while children with learning goals viewed the need for great effort as an opportunity to show their talent at mastery. Furthermore, the choice of goal can also affect learning. Children with learning goals are more likely to transfer learning to new situations while children with performance goals often fail to transfer learning (Farrell & Dweck, 1985).

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13 These causal dimensions were originally identified by Weiner (1986).

The *controllability* dimension refers to the ability to control the causal attribution. For example, mood and effort are both internal yet unstable causes, but effort is believed to be more under a person's control than is mood (Weiner, 1986). The relationship between perceiving events as *controllable* and achievement is interpreted in terms of "learned helplessness" and self-efficacy beliefs. Learned helplessness (Seligman, 1975) is an attributional pattern where no association is made between a persons own behaviour and outcomes, and such attributions can cause increased anxiety, lack of effort and lower achievement (Weiner, 1980). Attributional research is linked to more recent research which has investigated students' self-efficacy beliefs. Efficacy expectation is a belief that one can successfully execute behaviours that produce desired outcomes (Bandura, 1982). According to Bandura, efficacy expectations affect the choice of activity, the amount of effort expended, and the length of persistence at a task. Research into strategy use and self-efficacy beliefs is quite recent, and not clearly understood. Early findings suggest that people with low self-efficacy (i.e. doubt their capability) tend to give up while those with high self-efficacy put in more effort to meet a challenge (Palmer & Goetz, 1988). Evidence also suggests that academic self-efficacy may be related to academic performance (Wood & Locke, 1987). However, other factors may mediate this relationship as intrinsic motivation enhanced the relationship while the use of deep processing learning strategies did not (Smith, Pintrich & Doljanac, 1988).

In terms of the present study, the main questions are whether students believe they have control over their learning; and whether they attribute success to themselves or external forces. The relationship between self-control and achievement is not clear but may be stronger with adolescents than university students. The relationship between efficacy beliefs and achievement is also not straightforward and seems to be mediated by other factors such as goal orientations. Therefore, the predictions for this study are that no relationship will be found between control beliefs and academic performance; and no relationship between efficacy beliefs and academic performance.

Figure 1.1 shows that efficacy, control and outcome beliefs affect perceived competence and perceptions of task difficulty. **Perceived self-competence** is defined by the authors as "perceptions of ability to accomplish a particular task". Pintrich prefers the term "perceived self-competence" compared to the more static term "self-concept" because it reflects the active and dynamic interplay among self-perceptions. Bandura (1982) suggests that perceived self-competence is related to self-efficacy; while Harter (1983) suggests that positive self-concepts are related to higher achievement. Self-concepts can be specific (i.e. related to a particular domain) or more global (made up of domain specific self-concepts). **Perceptions of task difficulty** can affect expectations of success. For example, a computer science student may perceive a psychology exam to be more difficult than a computing exam, and thus have a lower expectancy of success. A psychology student may have similar perceptions of task difficulty and expectancy of success with a computing exam. However, the relationship between task difficulty, expectancy for success and achievement is not clear. For example, task difficulty and task value may interact. A computer programming course may be perceived to be difficult, but may also be recognized as having high task-value because programming skills may be highly valued. Students may therefore select this course even though expectancy for success may be low.

Figure 1.1 shows that **test anxiety** is placed near the perceived-competence construct, because the authors assume "student beliefs' influence test anxiety and test anxiety is negatively related to expectancy for success". For example, a student who consistently worries about taking exams, eventually worries about worrying. The greater the amount of worry, the greater the expectancy of failure. Two explanations for the effect of test anxiety on performance have been proposed: a cognitive skills deficit and an attentional interference deficit.

Tobias (1985) explains the negative effects of anxiety on performance in terms of a cognitive skills deficit. This explanation views students who suffer from test anxiety as having inferior learning skills, which leads to less effective processing of the to-be-learned material, which in turn leads to poor test performance. The learning skills include both macrolevel strategies (e.g. active reading, reviewing, monitoring, and metacognition) and microlevel strategies (elaboration, rehearsal, and imagery). This distinction between macrolevel and microlevel strategies seems similar to the distinction between high and low level strategies outlined earlier. So students are anxious about tests because they do badly on tests, but the reason for the poor performance is their poor learning skills.

Tobias also makes a distinction between learning skills (which are undertaken before a test) and test taking skills (which operate during a test). It is possible for students with ineffective test taking skills to do poorly in a test even if they have good learning skills and are well-prepared for a test. Eventually such students may become aware of their poor test taking skills and become anxious with interfering and distracting thoughts (e.g. "I don't know how to improve") competing with task relevant thoughts worsening test performance. Thus attentional interference (rather than a learning skills deficit) causes anxiety to effect performance. More recently evidence suggests that study skills and interference models should not be thought of as separate explanations of test anxiety, but "that different types of students possess different types of deficit". Students with high test anxiety but good study skills did better with non-evaluative tasks where knowledge can be used without interfering thoughts. However, with evaluative tasks these students did just as poorly as students with high test anxiety and poor study skills (Naveh-Benjamin, McKeachie & Lin, 1987). Based on the evidence, my predications are that students with high levels of test anxiety should perform poorly in exams. Also, a negative relationship is anticipated between test anxiety and self-efficacy beliefs for learning and performance.

The second type of pathway shown in Figure 1.1 is the **task-value path**. Two components are shown to affect achievement; task value and student goal orientation. Pintrich and colleagues describe 3 components of **task value**: attainment value; intrinsic interest and utility value. Basically, a task with high attainment value can be seen as a challenge and a "confirmation of smartness" (Eccles, 1983). High attainment value should increase involvement with the task. Intrinsic value relates to a person's inherent enjoyment of a task and is also believed to affect task involvement, but not necessarily achievement (e.g. a student can become engrossed in a task but yet fail to complete the task successfully). Utility value concerns how well a task achieves the students goals (e.g. a course may not be enjoyable but is required for recognition by a professional organisation such as the B.P.S.). The intention in terms of the present study is to investigate task value and academic performance. Research into the effects of these components on achievement is in its early stages and not clearly understood. However, my tentative prediction is that good students will be more likely to report high task value than poor students.

The second component in the task-value path is **student goals.** The goals students set themselves affect the way they value tasks. For example, students may approach a task with the expectation it will be enjoyable and interesting. Dimensions of **intrinsic motivation** such as challenge, mastery, independent judgement; and internal evaluative criteria are believed to affect involvement and intrinsic interest when learning (Harter, 1985). Covington & Beery (1978) argue that rather than being intrinsically motivated to learn, students are often motivated to "maintain their **self-worth** and self-esteem". This explanation views the learning environment as one of competition with students encountering more experiences with failure than success. Students are thus motivated to avoid failure rather than achieve success. For example, when students put much effort into a task and fail, failure is attributed to a lack of ability. This erodes self-worth, and effort comes to be seen as a double-edged sword: "*Effort increases the probability of success, but it also increases the potential for lack-of-ability attributions if failure occurs*" (Covington & Omelich, 1979). More recent reasoning emphasises that students adopt different goals with different tasks. In some situations they may adopt performance goals to get good grades or compete with others. This is similar to the self-worth goal orientation approach. In other situations they may adopt learning goals for mastery, challenge or curiosity. This is similar to the intrinsic motivation approach. The main point of interest in this study is whether students have intrinsic goal orientation which relates to the use of *learning goals*, or extrinsic goal orientation which relates to the use of *performance goals.* My prediction is that intrinsic goal orientation will be more closely associated with academic achievement than extrinsic goal orientation.

As well as the motivation components the MSLQ also contains scales which assess the use of cognitive and metacognitive strategies, and the use of resource management strategies. To facilitate academic success students need to have knowledge of learning strategies; they must be able to put this knowledge into practice and use the strategies; and they must also be motivated to use these strategies. Pintrich & Schrauben (1992) found that students motivated by intrinsic goals; with high levels of task value; and with high levels of efficacy beliefs "*are more likely to be cognitively engaged in learning through the use of cognitive and metacognitive learning strategies*" (pp 124). The prediction for this study is that good students are more likely to report these motivation components and are therefore more likely to report using the strategies described in the MSLQ.

1.6 - 1.8 Metacognition

Current views of learning see students as responsible for their own learning; and for students to accept this responsibility they must be motivated. However, as well as being motivated, students must also have the skills and abilities to actively engage motivational and metacognitive strategies (McCombs, 1988). Motivation and metacognition are inextricably linked. Motivation is concerned with the motives - or reasons - that lead students to learn. Metacognition is also an essential part of learning as it involves the ability to reflect on how one is thinking, and on the basis of this self-reflection, make deliberate choices about what strategies to use. One of the main reasons that people don't use reading strategies is that they don't engage in metacognitive activities. Metacognition is an essential part of learning and is defined as "one's knowledge concerning one's own cognitive processes and products or anything related to them" (Flavell, 1976). A learner is viewed as having the ability to reflect on how he or she is thinking, and on the basis of this self-reflection, make deliberate choices about what strategies to use. Metacognition involves two related abilities. The first ability concerns **explicit metacognitive knowledge** of cognitive processes and states such as memory, attention and reading strategies. The second ability concerns the ability to **control** or modify these processes. Evidence suggests that proficient learners are better both in terms of explicit knowledge of strategies and self-regulation of strategy use. These findings are discussed in Sections 1.6 and 1.7 respectively.

1.6 Explicit Metacognitive Knowledge

Evidence suggests that explicit metacognitive knowledge is needed for strategy use. Proficient learners have three types of explicit metacognitive knowledge which is needed for fluent use of reading strategies (Paris, Lipsom, & Wixson, 1983). First, *declarative knowledge* about what the strategy is and why it should be learned. For example, good readers know that re-reading a difficult text may enhance their understanding (Baker & Anderson, 1982). Second, *procedural knowledge* about how to use the strategy. For example, good learners know how to use key words when trying to decide what to re-read when comprehension problems arise (Garner, 1990). Third, *conditional knowledge* about why a strategy is important, when and where to use it, and how to evaluate its effectiveness. For example, good readers consider the demands of the task when choosing appropriate strategies (Forrest-Pressley & Waller, 1984). Such explicit metacognitive knowledge of strategies is crucial for the strategies to be used.

Evidence suggests that learners with metacognitive knowledge of the strategies they use when reading tend to be better readers. For example, Spring (1985) found that good but not poor readers reported a greater use of understanding strategies which facilitate learning. Metacognitive knowledge is investigated in this study with a reading strategies questionnaire based on the questionnaire used by Spring (1985). Spring compared good and poor readers' (first-year undergraduates) self-report ratings on a reading strategy questionnaire. Poor readers were enrolled on a remedial reading course while good readers had average or above average reading test scores. Spring found that poor readers tended to use *study* strategies without initially trying to understand the text content. In contrast good readers were more likely to use *comprehension* strategies that enhanced their initial understanding of the material. Spring defined study strategies as "... only those initiated by students for the purpose of remembering text material after initial comprehension of material." In contrast, comprehension strategies were defined as "required for *initial* text understanding rather than in their use of study strategies subsequent to initial understanding." Spring argued that initial understanding is more central to text learning than is subsequent study. Recall that Stevenson and Palmer (1994) equate study strategies with memorisation and comprehension strategies with understanding. Like Spring, they argue that understanding is the most successful method of learning as this involves evaluating, updating and possibly changing prior knowledge while memorisation merely involves the accumulation of new facts.

Spring classified the strategies into 5 different factors. There were three groups of study strategies: *verbal rehearsal* strategies which help students to memorise material; *written rehearsal* strategies which are the same as verbal rehearsal but involve the activity of writing; and *figural rehearsal* techniques which relate to drawing diagrams. Verbal rehearsal strategies consisted of rereading; underlining; asking questions; and restating the text in one's own words. Written rehearsal strategies consisted of taking notes; outlining; and summarising the text. Figural rehearsal consisted of drawing diagrams.

There were two groups of comprehension strategies: an *understanding* group of strategies and a *critical reading* group of strategies. Understanding strategies consisted of relating the text to prior knowledge; looking for logical relationships; and mentally identifying important ideas. Critical reading strategies consisted of relating the text to one's attitudes and beliefs; to one's experiences; to one's emotions; and thinking about how the material could be used.

Spring found no difference in the reported use of study strategies by good and poor readers. However good readers had significantly higher ratings than poor readers with the strategies from the Understand factor, and Spring concluded that the Understand factor best discriminated between good and poor readers. The reading strategies questionnaire used in this study includes Spring's 15 items, but also included an additional 7 items which have all been defined as high-level constructive strategies by Pressley & Afflerbach (1995) in section 1.4: relating different parts of the text to get the gist; monitoring comprehension; challenging or considering the author's intentions; predicting future text content; and reading ahead with the hope that comprehension problems will be resolved later; and identifying and defining unfamiliar terms or content. These additional items together with Spring's items are shown in the appendix, table A1.1.

The main question for this study is whether there is a relationship between the type of reported reading strategy (comprehension or study) and learning ability (good or poor learner). My predictions are that (1) good learners will report more frequent use of understanding strategies; (2) both groups will report using study strategies with similar frequency; and (3) both groups will report using critical reading strategies infrequently.

Section 1.7 Self regulation of strategy use

Although explicit knowledge seems necessary for strategy use, it is not enough for successful learning. The ability to put the knowledge into practice is also needed. That is, learners need to *regulate* their performance by monitoring comprehension and responding by using fix-up strategies when comprehension breaks down. Metacognitive skills underlie successful comprehension monitoring, as monitoring involves the continual evaluation of the success or failure of comprehension. Earlier studies of comprehension monitoring suggested that both young children (Markman, 1979) and college students (Baker, 1979) often failed to report logical inconsistencies in text; that older children compared to younger children were more able to recognise their own monitoring abilities (Pace, 1981); and that skilled readers were better than less-skilled readers at monitoring their comprehension and using this information to regulate strategy use (Glenberg & Epstein, 1985). Poor cognitive monitoring can lead to an illusion of knowing. More accurate evaluation of comprehension influences the use of appropriate strategies such as re-reading a difficult section of text. If comprehension failures are detected, what do readers do? Kletzein (1988) found that good and poor readers used the same, small set of strategies (re-reading and making inferences) when reading easy texts, but with more difficult texts, good readers persisted in their attempts to understand while poor readers gave up. Fischer & Mandl (1984) found similar differences, with good readers regulating their progress by using strategies to overcome comprehension failure while poor readers attributed negative feeling to themselves and to their abilities as learners.

However, more recent evidence suggests that even skilled readers are not uniformly good comprehension monitors, and do not monitor consistently. Pressley & Ghatala (1990) were concerned that earlier studies of monitoring text comprehension had used the error detection paradigm as a measure of comprehension monitoring; and cited Winograd & Johnson's (1982) alternative explanations for readers failing to detect errors. For example, readers may lack background knowledge; may not believe printed text could contain errors; may make interpretations of the text differing from those intended by the author; and may notice an error but believe later text will resolve it. From a series of studies Pressley and Ghatala concluded "... *that monitoring during reading may not yield sufficient metacognitive information to permit maximally efficient, self-regulated study and use of reading strategies. More positively, taking a test or answering adjunct questions during reading enables college students to monitor their learning performance accurately*" (1987, p 24).

These recent findings imply that the students in the present study may also have poor self-regulatory skills. Self-regulation will be investigated by identifying the strategies used following comprehension failure when reading. My prediction is that good learners will use more strategies to overcome comprehension failure than poor learners. It is possible however, that attempts to overcome comprehension failure will be few and far between - with both good and poor learners.

1.8 Reported versus observed strategy use

The main point of concern in this section is whether students actually use the strategies they say they use. One limitation of using self-report measures is that learners can report what they think they should be doing and not what they actually do. Evidence from comparative studies of self-report versus observed measures of strategy use is equivocal. Cavanaugh & Borkowski (1980) investigated reported knowledge of memory (or metamemory) and observed memory performances with children. Metamemory was tested in an interview while memory performance was assessed by recall of a categorizable list. The authors found that amount of knowledge about strategies did not distinguish the children who used strategies from those who did not. Furthermore, when the children were categorised as having high vs low metamemory and high vs low memory performance, good verbalizable metamemory was not found to be necessary for successful memory performance. In contrast, Waters (1982) found the self-reported strategy use of 13 and 15 year olds accurately reflected their actual strategy use. Waters established a link between metamemory and performance as children who knew that elaboration was a better strategy than non-elaborative study strategies performed better at recalling word pairs. Also, a link between strategy use and performance was established as children who used elaboration more frequently also recalled more word pairs. Furthermore, older children recalled more word pairs than younger children, which suggests age differences are a function of increasingly effective elaborative strategies.

Both Cavanaugh & Borkowski and Waters investigated childrens' strategy use so their findings can not be generalised to undergraduates. Phifer & Glover (1982) investigated reported and observed strategy use of college students, and found the students did not consistently use the metacognitive strategies they reported using. Phifer & Glover categorised the students as high and low comprehenders using the Nelson-Denny Reading Comprehension Test. Subjects read texts on solar evolution, underlined the main ideas in the text while reading, and recalled the main ideas after reading. With observed strategy use, high comprehenders underlined more ideas while reading and also recalled more ideas than low comprehenders. This suggests that high comprehenders distinguished salient textual information in the text and also processed this information in a way that facilitated later recall. However, no significant differences were found with reported use of strategies. In contrast, Alexander (1986) found consistency between reported and observed strategy use. Undergraduate students who reported using the underlining strategy did apply this strategy when reading while those who did not report using this strategy did not apply it.

Brennan, Winograd & Bridge & Hiebert (1986) also found strong agreement between self-report and observed measures with underlining, but not with other strategies. Reports of strategy use for most strategies were considerably higher than that observed in practice. With observed strategy use, the most frequently used strategies were underlining (90%); listing the important ideas (34%); rereading (32%); and relating text segments to one another (30%). Only 18% took notes or outlined the text while reading. With self-report measures, there was strong agreement with underlining only (84%). The authors described students as having "a preference for underlining while reading with little activity before or after reading". These findings support those of Simpson (1984), outlined in section 1.3, who found that students used a restricted range of low-level strategies often failing to employ high level monitoring and evaluation strategies.

The picture emerging from section 1.8 is one of optimistic students who have at least some surface understanding of what they should be doing. However, they frequently fail to act on this metacognitive knowledge. Perhaps students have the declarative knowledge about what the kinds of strategies they should be using, but don't have the procedural knowledge about how to put these strategies into practice. Alternatively, they may not have the motivation to put the strategies into practice. In terms of this study, my prediction is that the greatest agreement between reported and observed strategy will be with low-level strategies (e.g. underlining) rather than high-level strategies (e.g. elaboration); and with good rather than poor learners.

1.9 Representation, prior knowledge and inference

The final characteristic considered in this thesis is the role played by **representation, prior knowledge and inference**. Prior knowledge can facilitate reading and has also been shown to affect the type of representation constructed and the generation of inferences during reading. These pertinent issues are considered in this section.

Substantial evidence has found that prior knowledge facilitates reading. Evidence from expert/novice studies has shown that domain specific knowledge can compensate for the memory and metacognitive deficits of children; for aptitude; and for learning ability. Chi (1978) found that child chess experts recalled more chess positions than adult chess experts showing that domain specific knowledge can compensate for the memory and metacognitive deficits of children. Schneider, Korkel & Weinert (1989) found that domain specific knowledge can compensate for low aptitude, as low aptitude soccer experts outperformed high aptitude soccer novices on the recall of main ideas from a soccer story. Prior knowledge can also make it easier to identify important information when reading. For example, Recht & Leslie (1988) found prior knowledge enhanced understanding by making it easier to select the main ideas and make inferences when reading As this was found with both good and poor readers, prior knowledge may compensate, at least to some degree, for learning ability.

Evidence also suggests that domain specific knowledge can facilitate the acquisition of a strategy. Gaultney (1995) trained child readers with expert baseball knowledge to use the reading strategy of asking "why" questions. When trained with familiar baseball stories (as opposed to unfamiliar stories) the children comprehended the text with greater ease and automaticity, which released more memory capacity for acquisition of the new strategy. However, although prior knowledge may facilitate the acquisition of a new strategy, it may diminish the use of previously learned reading strategies. Bereiter & Bird (1985) suggest strategies may only be used when comprehension problems arise, such as when a reader's background knowledge is insufficient. When reading more familiar material, reading is accomplished with fewer comprehension problems. On the other hand, familiarity with text content does appear to facilitate monitoring. For example, Gaultney (1995) found greater monitoring when children read stories from their domain of expertise; and Garner (1990) found readers were less likely to monitor text comprehension when reading difficult or unfamiliar material and were struggling to understand the text content.

Alexander et al (1997) tried to explain the facilitative effects of prior knowledge on strategy use. They investigated specific changes in strategy use and domain knowledge over a semester in a formal instruction course in educational psychology with college students. They predicted a ".. *decrease in the role that general strategies play in academic performance, largely due to the students' expanding foundation of domain knowledge and to the accompanying automaticity experienced for more common-place domain tasks.*" (p129). Results did not support their prediction, as overall strategy use increased significantly during the course. However, a trend showing qualitative changes in strategic behaviour was found. Use of lower-level text manipulation strategies (re-reading, using context to determine meaning) decreased while use of higher level strategies (strategies for building mental models, elaborating main ideas) increased. The undergraduates directed their cognitive and metacognitive efforts differently as they become more knowledgeable in the domain, using fewer text-based strategies and focusing more on deep processing strategies that helped them identify the main ideas and build mental representations of what they were reading.

To investigate prior knowledge in the present study, the level of familiarity with text content was manipulated. Each student read a text from a familiar topic as well as a text from an unfamiliar topic. Students were asked to think aloud their thoughts while reading, and strategies were identified from the verbal protocols. Based on the above evidence, my predictions are that strategy use will be greater with unfamiliar texts; while monitoring and control of the strategies will be greater with familiar texts.

The second point of interest in the present study was the effect of learning ability on the type of text representation constructed during reading, since the evidence suggests that prior knowledge and reading comprehension skill have different effects on representations of text content. Before considering this evidence, an outline of the types of representation constructed while reading is necessary. Both Kintsch (1988, 1992) and Johnson-Laird (1983) have developed models which describe how representations are constructed while reading. However, Kintsch has addressed the issue of levels of understanding in *learning from text*; therefore I refer to Kintsch's model of reading comprehension rather than Johnson-Laird's. The conclusions drawn however, are applicable to both models of text representation.

Kintsch's model assumes that three types of representation are constructed when reading. The first is a *surface* representation where the words are encoded along with the linguistic relations between them. The second is a *textbase* representation where the semantic and rhetorical structure of the text is represented. The third level is a *situation model* where the information in the text is elaborated and integrated with prior knowledge. How a text is represented when reading determines how well the material will be understood. Kintsch (1994) explains the difference between remembering and understanding material in terms of the representation constructed while reading. For remembering text, the semantic and rhetorical structure of a text encoded in the textbase representation is sufficient to reproduce the text content in verbatim form. This representation is adequate for recalling and even summarising a text by reproducing the most active propositions from memory, however, understanding will only be superficial. To learn from text, a deeper understanding is needed so that the reader can make inferences, interpretations, and use the information in new situations. This deeper understanding comes from the process of elaborating and integrating the text content with prior knowledge.

Of interest in the present study is whether prior knowledge affects the representation constructed when reading. Voss & Silfies (1996) investigated the effects of both prior knowledge and reading comprehension skill when reading and interpreted their findings in terms of Kintsch's model of reading comprehension. Their premise was that reading comprehension skill should be primarily related to textbase development because reading skill is related to working memory capacity. Good comprehenders should therefore recall and store more textual information because of more efficient and effecting processing. In contrast, subject-matter knowledge should be primarily related to situation model development. This seems reasonable as situation models require the integration and elaboration of the text content with prior knowledge. Two different texts were used to induce different levels of representation: an expanded text explained the causal relations between events; an unexpanded text had a less developed causal structure leaving "gaps" in the content. The reasoning was that expanded texts would require only reading comprehension skills and thus textbase representations should be constructed. In contrast, with unexpanded texts prior knowledge is needed to "fill the gaps" and thus situation models should be constructed. The results supported these hypotheses. Reading comprehension skill but not knowledge correlated with the expanded text; knowledge but not reading skill correlated with the unexpanded text.

Given this framework, the good learners in this study should be more likely to construct a situation model when reading, because they are more likely to have a better knowledge of the subject matter of the texts. Investigation of this proposal was carried out in three ways. First, by the number of **warranted inferences** (i.e. inferences that are plausible given that the text is true) made when subjects read the texts. Evidence on the generation of inferences has shown that people with a rich knowledge of the subject of a text are more likely to make inferences based on their background knowledge compared to less knowledgeable readers (Kintsch, Welsh, Schmalhofer and Zimny, 1990). The more knowledge one has of a topic, the more likely the situation described by a text will be recognized and enriched with inferences based on that knowledge. Given this evidence I predicted that good learners would (1) produce more inferences than poor learners; and (2) produce more inferences with familiar than unfamiliar texts. Also as more knowledgeable readers have a richer set of constraints, I predicted that all students would produce more unwarranted inferences with unfamiliar texts.

The second way of investigating text representations was with **summaries of the main points** of a text. All students were asked to provide a written summary when they had finished reading. Five types of ideas were identified; local, global, topic, general and incorrect ideas. Local ideas reflected information from just one sentence in the text; global ideas reflected information from two or more sentences in the text; topic ideas concerned the subject of the whole text; general ideas contained little textual detail or reflected the reader's prior knowledge rather than the text content; and incorrect ideas were not consistent with the text content. In terms of Kintsch's model of reading comprehension, local and global ideas reflect two levels of understanding, the textbase and the situation model. Local ideas reflect the construction of a textbase representation as the text content is not elaborated or integrated with other information in the text. In contrast global ideas reflect the construction of a situation model as some inferencing is needed to link information from one sentence to that of another. It seems that good readers focus on main points while poor readers focus on details. For example, Commander & Stanwick (1997) found that when recalling ideas from the texts, poor readers focused on local details at the cost of understanding the main ideas of the texts, while good readers recalled more global ideas. Good readers were more sensitive to the structural elements within the texts which enhanced their recall of main ideas. In terms of this study I predicted that good learners would produce more ideas - in particular more global ideas - in their summaries; and that more ideas would be produced with familiar than unfamiliar texts.

The third way of investigating the effects of prior knowledge involved devising questions to determine differences in domain knowledge. Devising the questions was a labour intensive exercise, and was therefore only carried out with third year students taking a cognitive science course. Three different types of questions were devised. Prior knowledge questions assessed a basic level of understanding of cognitive science and not the actual topic of the text, and were given to students before they read the cognitive science text. Two types of questions were devised to test memory of the text content after reading; textbase questions and situation model questions. The answers to textbase questions could be found in one sentence of the text, while answers to situation model questions required information from two or more sentences to be linked. McNamara, Kintsch, Songer & Kintsch (1996) state that textbase questions primarily tap superficial understanding while situation model questions tap a deeper level of understanding and to construct a situation model "*active inferencing and prior knowledge are needed .. without adequate prior knowledge, students are limited in their constructive processes*". The implications for this study are that there should be a positive relationship between prior knowledge test scores and the construction of situation models, and that this relationship should be stronger with familiar than unfamiliar texts.

1.10 Tying up the threads

The main aim of this thesis is to identify characteristics that distinguish good from poor learners. The remaining chapters investigate characteristics that have been shown to play an important role in learning. Chapter 2 investigates whether strategy use differentiates good from poor learners with a verbal protocols experiment. The research also indicates that a qualitative change in strategic behaviour takes place with study experience. However, previous studies used reported rather than observed measures of strategy use so the emergence of a genuine qualitative change in strategic behaviour has not been clearly established. This problem is investigated in chapter 5 which is described shortly.

Chapter 3 investigates whether motivation can distinguish good from poor learners. The Motivated Strategies for Learning Questionnaire, or MSLQ (Pintrich, Smith, Garcia & McKeachie, 1991) is used to investigate the motivation components of goal orientation, task value, efficacy beliefs, control beliefs, expectancy for success and test anxiety.

Chapters 4 and 5 investigate the role played by metacognition in learning. Chapter 4 investigates one aspect of metacognition - explicit metacognitive knowledge of strategies - with a questionnaire on the frequency of use of reading strategies. The other aspect of metacognition - the self-regulation of strategy use - is investigated in the verbal protocols experiment when strategy use following comprehension failure is investigated. The question of whether students actually use the strategies they say they use has not been resolved. This problem is investigated in chapter 5 when reported strategy use (obtained from the reading strategies questionnaire) is compared with observed strategy use (obtained from the verbal protocols experiment). If students do not use particular strategies we need to understand whether they lack the metacognitive knowledge of what strategies are, when to use them and how to use them; or whether they lack the motivation to use them. With a better understanding of why students fail to use some strategies we can target our efforts and resources more effectively.

Chapter 6 investigates the effects of representation, inference and prior knowledge on reading. The research indicates that learning ability affects the type of representation constructed when reading and that prior knowledge facilitates reading and the generation of inferences. The type of representation constructed when reading is investigated with written summaries of the main points of the texts in the verbal protocols experiment. The generation of inferences and the effect of prior knowledge on reading is investigated in the verbal protocols experiment by presenting texts from familiar and unfamiliar topics. Representations and prior knowledge are investigated in more detail in the students' final year with questions designed to tap their prior knowledge and memory for text content. A critical skill that undergraduates need to develop is the ability to integrate new information with their pre-existing knowledge, and also to evaluate and update prior knowledge with respect to new information Representation inference and prior knowledge play a vital role in the acquisition of this skill, but how these characteristics distinguish good from poor learners is not clear and warrants further investigation.

Two main threads run throughout the experiments in this thesis. Some characteristics seem to distinguish good from poor learners, and some characteristics seems general to all undergraduate students. Some overall conclusions about these characteristics are drawn in the final discussion in chapter 7. If we have a better understanding of the characteristics that distinguish good from poor learners, we have a better chance of enhancing the achievements of the poor learners. Poor learners may want to improve the strategies they use to learn, but perhaps don't know how to, or even worse, don't realise that the strategies they use could be improved.

CHAPTER 2

Verbal Protocol Experiment

2.1 Aims of the verbal protocol experiment

This experiment is designed to investigate the comprehension strategies used by good and poor learners. Learners spend much of their time at university reading expository texts, and the strategies they use will vary depending upon their personal preference for particular strategies; how much study experience they have; and how familiar the text is. The aim of this experiment is to investigate the effects of learning ability, study experience and text familiarity on comprehension strategy use. This is achieved by asking students in each of their first, second and third years to think aloud their thoughts while reading familiar and unfamiliar expository texts. From the resulting verbal protocols comprehension strategies are identified.

The evidence reviewed in chapter 1 suggests that beginning university students tend to use a restricted range of study strategies, relying mainly upon low-level strategies such as re-reading and underlining rather than high-level strategies such as evaluating and monitoring their understanding (Simpson, 1984). However, longitudinal studies suggest that strategy use undergoes a qualitative change with study experience; more specifically the use of high level strategies increases while the use of low level strategies decreases (Watkins & Hattie, 1981; Bartling, 1988). Strategy use is more likely with unfamiliar material as a lack of background knowledge can cause comprehension failure (Bereiter & Bird, 1985). Inferences, on the other hand, are more likely to be made with familiar texts, as prior knowledge can facilitate the generation of inferences (McNamara, Kintsch, Songer & Kintsch, 1996). Monitoring is also more likely when reading familiar material as readers can comprehend familiar content with more automaticity which relieves working memory capacity for monitoring activities (Gaultney, 1995).

Comprehension monitoring plays an important role in self-regulated reading. Self regulation involves monitoring comprehension and recognizing when comprehension failure arises. Once aware of breakdown in comprehension, strategies can be employed to overcome the source of comprehension failure. Earlier studies suggested good readers are better than poor readers at self-regulating their reading (Fischer & Mandl, 1984). However, more recent research suggests that a lack of ecological validity with the materials and tasks used in many of these studies contrived to give this optimistic portrayal. More recent research has shown that even skilled readers, such as university students, often fail to monitor their comprehension and self-regulate their reading (Pressley & Ghatala, 1990).

One further prediction is investigated in this chapter. In the literature review in chapter 1 the argument was made that exam performance is a better long-term measure of learning than reported ratings from the Learning and Study Strategies Inventory (LASSI). Because of this argument, both measures of learning were used. The reason for this was to see whether both measures could detect between groups differences in strategy use as well as similarities in strategy use which were characteristic of both groups. The comprehension strategies used by students with the *highest and lowest final exam scores* is reported and discussed in this chapter. The comprehension strategies used by students with the *highest and lowest reported LASSI ratings* are reported in the appendix, table A 2.5, where the two measures of learning are contrasted and compared.

2.2 The following predictions are proposed:

Comprehension strategy use

1. Good learners will use more comprehension strategies than poor learners.
2. Good learners will use a greater number of different strategies than poor learners.
3. Strategy use will increase as students gain more study experience.
4. There will be a qualitative change in strategy use with experience, or more specifically, an increased use of high-level strategies and a decreased use of low-level strategies with experience.

Comprehension monitoring

5. Good learners will monitor their comprehension more frequently than poor learners.
6. Monitoring will be greater with familiar than unfamiliar texts.

Self regulation

7. Good learners will use strategies to overcome comprehension failure more frequently than poor learners by using more strategies when they express comprehension failure.

Inferencing

8. Good learners will make more inferences than poor learners.
9. The generation of inferences will increase as students gain more study experience.
10. More inferences will be made with familiar than unfamiliar texts.

Method

The verbal protocol experiment is reported in four sections. Section 2.3 justifies the methodology used. Section 2.4 describes the materials and the identification of "good" and "poor" learners from reported ratings of the Learning and Study Strategies Inventory (LASSI). Section 2.5 describes the identification of "good" and "poor" performers from examination scores. Finally, Section 2.6 describes the materials, design and procedure of the experiment.

2.3 Discussion of the methodology

The aim of this experiment was to identify the strategies used by students when reading expository texts. This was accomplished by asking students to think aloud their thoughts while reading the selected texts. From the resulting verbal protocols, reading strategies are identified. The reliability and validity of using verbal protocols to identify the processes used when reading have been debated for some time, most notably by Ericsson and Simon (1984; 1993) and Nisbett and Wilson (1977). I will outline some of the problems with verbal protocols and describe the procedures adopted in this study to constrain these problems.

The aim of think aloud protocols is to gain access to people's on-line thought processes from which processes such as reading strategies can be identified. However, whether people can accurately report the processes they use has been questioned. One argument against verbal protocols is that some processes have become highly automated and therefore are not available for conscious introspection (Cavanaugh, 1982; Nisbett and Wilson; 1977). Ericsson & Simon (1984; 1993) reply that while some highly automated processes may not be available for introspection, people can report the contents of currently active short term memory, and therefore some indication of the processes used during reading can be gained. Thus, although verbal protocols may be incomplete, they can still reveal useful information about strategy use.

While fully automized processes are difficult to report, one solution is to manipulate the level of difficulty a text poses. For example, thinking aloud when reading an easy text results in simply reading aloud; while thinking aloud when reading a difficult text results in "substantial verbalization of information not explicitly given in the text" (Ericsson & Simon, 1993). To address this problem in this study a great deal of time was spent finding challenging texts that both engaged the students and required some effort for understanding. Furthermore, in order to make accurate predictions about strategy use, an understanding is needed of how reading processes vary with differences in prior knowledge (Ericsson & Simon, 1993). For example, a reader with rich knowledge of biology will use different processes when reading a biology text compared to a reader with no prior knowledge of biology. The effects of prior knowledge were explored in this study by manipulating the level of familiarity of the texts used in the reading experiment. Further investigations of prior knowledge on reading are discussed in Chapter 6.

Ericsson & Simon (1984) issued guidelines to facilitate "supportive reflective-access conditions" and many of these were incorporated in this study. For example, the interval between using and reporting strategies should be as short as possible with people reporting specific events rather than hypothetical situations. Also, people should be asked *what* they do and think - not *why* they do so - as greater cognitive resources are needed to explain why a process is being used. In contrast, if readers are simply asked to report the contents of their short term memory this does not seem to qualitatively affect processing. Ericsson & Simon concluded that thinking aloud is a natural process for adults that doesn't require long training periods. However, people can forget to report their thoughts and may need prompting. To limit these problems in this study, students were instructed to stop after they had read one or two sentences of text and say out loud whatever thoughts were in their minds. If students stopped thinking aloud, they were prompted by the experimenter and asked if they had any thoughts to report. Students were not asked to report selected processes as this would introduce bias, they were simply asked to report whatever thoughts were in their mind. This lead to the inclusion of many thoughts, strategies, evaluations and the occasional profanity; however it did capture a more natural picture of what students tend to think about when reading.

To identify the strategies used by students in this study, subjective decisions are used to classify comments as evidence of strategy use. For example, the comment *"I'm noticing that (the text) said constructive process again and I'm just thinking back to what the actual constructive theory was at the beginning of the text"* is categorised as the reading strategy of *linking text segments*. To assure reliability of the categorisation procedure reliability statistics were obtained. First, the verbal protocols were segmented into utterances (i.e. single ideas) with a sample, ranging from at least 20% and at most 100%, segmented by a second independent judge. For each year inter-rater reliability was high with the following Pearson correlation coefficients: yr 1 $r = 0.97$; yr 2 $r = 0.99$; yr 3 $r = 0.99$. Second, the utterances were then categorised as reading strategies, and reliability for the categorisation of reading strategies, monitoring strategies and inferences was again high (Cohen's Kappa: yr 1 $k = 0.85$; yr 2 $k = 0.80$; yr 3 $k = 0.90$).

Another problem with verbal protocols is that of a "general verbal skill deficiency among some learners" (Cavanaugh & Perlmutter, 1982). Put simply, some students find it more difficult to put into words what they are thinking than others. This is a difficult problem to address and one that most researchers using the think aloud technique will be familiar with. One way to resolve this problem is to adopt a repeated measures design where students are compared with themselves rather than other students. In this study, students were compared reading familiar and unfamiliar texts, so the issue of individual differences, on this factor at least, was eliminated. However, comparisons of good and poor groups will be influenced to some extent by individual differences in general verbal skills.

The use of a repeated measures design also allowed me to address a particularly important criticism of verbal report data; *that stability over time has been greatly neglected* (Garner, 1988). By studying the changing nature of strategy use we can enhance our understanding of the processes students use while reading and learning. The effects of increased study experience and knowledge is one of the central questions in this study, and is addressed by comparing strategy use in the students' first, second and third years of study. Finally, there are advantages of using verbal protocols compared to other methods. For example, students who do well on standardised reading comprehension measures can perform poorly on assignments and exams. Nist & Kirby (1986) believe this arises because exams measure products of comprehension rather than process. One advantage of using think aloud protocols is that deficits in process can be identified. Another reported benefit of thinking aloud is that it can help participants gain more insight into their own comprehension processes (Block, 1986; Nist & Kirby, 1986).

2.4 Selection of good and poor learners from LASSI ratings

Materials The LASSI is a 77-item self-report Inventory, which uses a 5 point Likert-type scale. Students were asked to rate themselves according to how well a statement described them ranging from **a** (not at all typical of me) to **e** (very much typical of me). The 10 scales were attitude; motivation; time management; anxiety; concentration; information processing; selecting main ideas; study aids; self-testing; and test strategies. A full list of items can be seen in the appendix, table A2.1. Examples of LASSI items are:

(a) I only study when there is the pressure of a test. (*Time management*)
(b) I talk myself into believing some excuse for not doing a study assignment. (*Motivation*)
(c) I feel very panicky when I take an important test. (*Anxiety*)

Students 169 undergraduates formed an initial pool of students who were attending an "*Introduction to Psychology*" degree course. 152 students were first-year undergraduates; the remaining students were either second or third year undergraduates and were discarded from the selection procedure as the study required three years commitment. From the first-year students, 21 "good" and 19 "poor" learners were selected to take part in this experiment. 18 good and 12 poor learners were studying for a single honours or joint honours degree with psychology. The remaining 10 students took degrees in the following non-psychology subjects; Sociology, Economics, English Language, English Literature, Computer Science, and Cell Biology.

Selection of samples Two different methods were used to identify a sample of "good" and "poor" learners from the LASSI profiles. First, the means of all 10 LASSI scales were calculated. Second, the scale scores were ordered according to predetermined cut-off points: scores above the 75th percentile; scores between the 50th and 70th percentile; and scores below the 45th percentile. Weinstein (1987) suggests that students with scale scores above the 75th percentile do not need to work on the skills for that scale, as a high score implies students are employing appropriate skills. Students with scores between the 70th and 50th percentile should consider improving the skills for that scale to optimise academic performance. Students with scales below the 45th percentile need to improve the relevant skills to increase chances of success in higher education. The number of scale scores between these 3 cut-off points were rank ordered. For example, the student with the highest scale ordering had 9 scales above the 75th percentile and 1 scale between the 50th and 70th percentile. The student with the lowest scale ordering had all 10 scales below the 45th percentile. If two or more students had the same number of scales between the same cut-off points, the actual scale scores were used to order the profiles. For example, two students (LW and SS) each had 9 scales above the 75th percentile, and one scale between the 50th and 70th percentile. Both students had identical scores on 5 of the 9 scales above the 75th percentile.

However, student SS had higher scores on the remaining 4 scales, and was therefore ranked above student LW.

The aim was to recruit 15 - 20 good and 15 - 20 poor learners - but a greater number was targeted as I anticipated a number of non-respondents. Therefore 33 students with the highest scores according to both selection methods were identified and asked to participate. 21 students agreed and they became our sample of good learners. For good learners in their first-year, the mean LASSI scores ranged from 27.9 - 35.0: the highest ranked profile had 9 scales above the 75th percentile and 1 scale between the 50th and 70th percentile; while the lowest ranked profile had 8 scales between the 50th and 70th percentile and 1 scale below the 45th percentile.

33 students were then identified with the lowest scores according to both selection methods, and were asked to participate. Of these students, 16 agreed to take part, 3 had left the university, 2 declined to take part in the study, and 12 did not reply to repeated requests for participation. A further 9 students with the next lowest scores were asked to participate, and from this extended selection, 3 agreed to take part. Thus, we had identified our sample of 19 poor learners. For poor learners in their first year, the mean LASSI scores ranged from 20.2 - 24.7; the highest ranked profile had 2 scores above the 75th percentile, 3 scores between the 50th and 70th percentile, and 5 scores below the 45th percentile while the lowest ranked profile had all 10 scales below the 45th percentile.

Subjects also completed the LASSI in their second and third years. Of the 19 poor learners identified in the first-year: 3 had mean scores and percentile scores that fell within the range of good learners in the second and third years; and 1 failed to keep several appointments to participate in the third-year. Thus verbal protocols from the remaining 15 poor learners were accepted for analysis. Of the 21 good learners identified in the first-year: 2 had LASSI mean scores very close to the range of poor learners in the second and third years; 2 failed to keep several appointments to participate in the third year; and the protocols from 2 students were partially lost due to technical problems with the tape recorder. Thus verbal protocols from the remaining 15 good learners were accepted for analysis. The range of means for both groups were mutually exclusive in the second (good 27.2-33.5; poor 18.9-26.2) and third (good 28.1-34.4; poor 19.2-26.9) years. The mean scores for good and poor learners in years 1, 2 and 3 are shown in Figure 2.1.

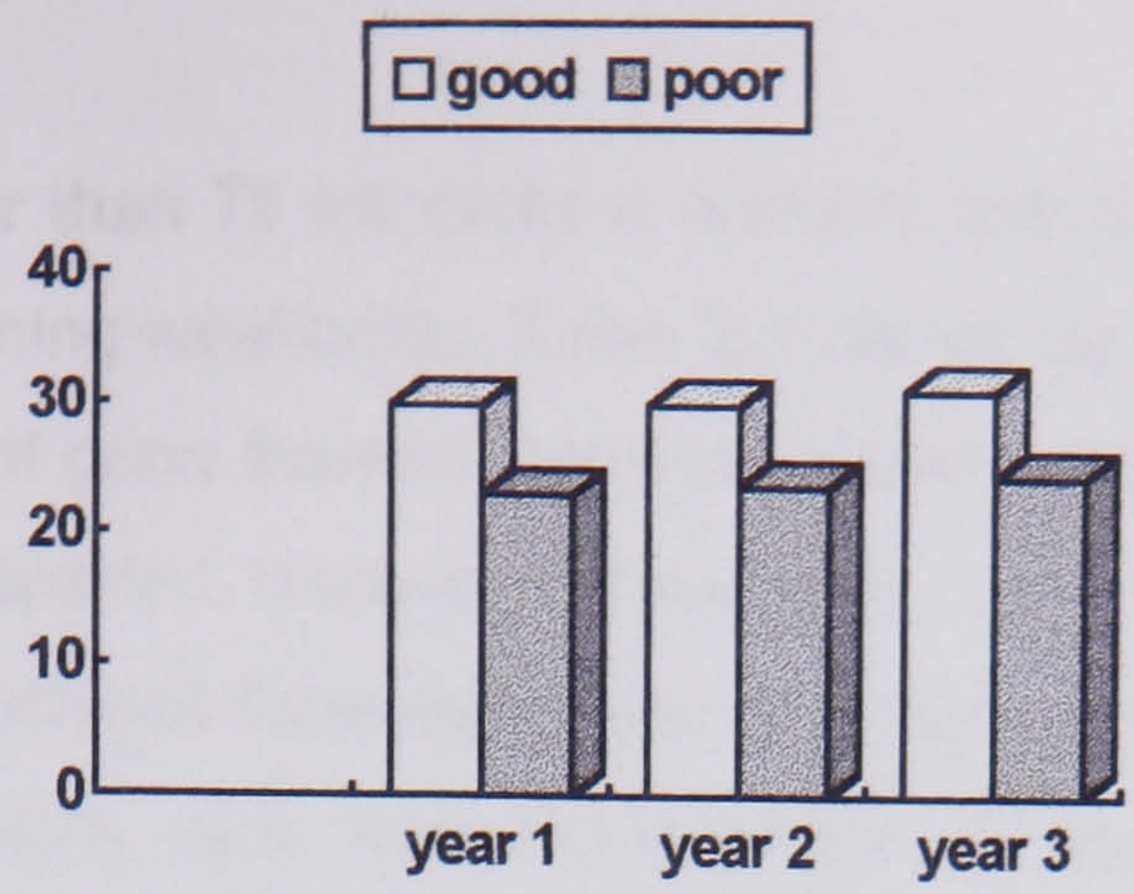


Figure 2.1 Mean LASSI scores for good and poor learners.

Analysis of the data in Figure 2.1 found a significant difference between the 2 groups ($F=170.33$, df 1,27, $p<.001$); good learners (mean 30.5) had higher mean scores than poor learners (mean 23.1). A significant difference between the 3 years was also found ($F=4.43$, df 2,54, $p<.02$); the ratings increased from year 1 (mean 26.5) and year 2 (mean 26.6) to year 3 (mean 27.6). No interaction was found ($F<1$). The percentage of good and poor learners with scores above the 75th percentile are shown in Table 2.1 while scores below the 45th percentiles are shown in Table 2.2.

Learning strengths: (percentiles > 75)	att %	mot %	tmt %	anx %	con %	inp %	smi %	sta %	sft %	tst %
year 1										
good	73	60	93	20	86	40	66	53	40	80
poor	40	0	0	26	13	0	13	6	0	26
year 2										
good	73	66	86	40	80	40	80	60	60	73
poor	20	0	6	33	6	0	13	13	0	46
year 3										
good	86	80	93	53	86	46	80	80	73	80
poor	13	0	0	13	20	0	26	20	6	26

Table 2.1 Percentage of students with LASSI scale scores above the 75th percentile.

Code: **att** attitude; **mot** motivation; **tmt** time management; **anx** anxiety; **con** concentration; **inp** information processing; **smi** selecting main ideas; **sta** study aids; **sft** self-testing; **tst** test-taking strategies

Learning weaknesses: (percentiles < 45)	att %	mot %	tmt %	anx %	con %	inp %	smi %	sta %	sft %	tst %
year 1										
good	13	0	0	46	0	40	6	26	6	6
poor	40	86	93	60	73	86	73	93	80	53
year 2										
good	6	6	0	26	6	40	13	33	6	6
poor	60	86	86	33	80	100	66	60	86	40
year 3										
good	0	6	0	33	0	26	20	6	6	0
poor	42	78	78	42	64	85	35	64	85	50

Table 2.2 Percentage of students with LASSI scale scores below the 45th percentile.

A percentile score of greater than 75 indicates a learning strength while a percentile score of less than 45 indicates a learning weakness. Table 2.1 shows that for all scales except anxiety, a much greater percentage of good learners reported learning strengths while Table 2.2 shows many more poor learners reported learning weaknesses. The percentage of good learners reporting learning strengths ranged from 40% (with information processing in years 1 & 2 and self testing in year 1) to 93% (with time management in years 1 & 3). In contrast, the percentage of poor learners reporting learning strengths ranged from 0% (with motivation and information processing in all 3 years; time management in years 1 & 3; and self-testing in years 1 & 2) to 46% (with test strategies in year 2). The percentage of good learners reporting learning weaknesses ranged from 0% (with time management in all 3 years; attitude in year 3; motivation in year 1; concentration in years 1 & 3; and test taking strategies in year 3) to 40% (with information processing in years 1 & 2). In contrast the percentage of poor learners reporting learning weaknesses ranged from 35% (with selecting main ideas in year 3) to 100% (with information processing in year 2). With anxiety, a low percentile score indicates a high level of anxiety. In the first year nearly half of the good learners and two-thirds of the poor learners reported very high levels of anxiety. By the third year this had reduced to about one-third of good and of poor learners. The reported ratings of both good and poor learners were accepted as consistent over the 3 years according to both selection methods.

2.5 Selection of good and poor learners from exam scores

Selection of samples In the second stage of this study, final exam scores were used to classify students with high and with low exam scores. Written permission was obtained from each student for access to their final examination scores. Exam scores were marked from 0 to 100, although the majority of exam scores were between 50 and 70. 13 students with the highest median exam scores (range = 63.5 to 71) and 13 students with the lowest median exam scores (52 - 60.5) identified. Students with median exam scores between 61 and 63 were omitted to accentuate the range between the 2 groups.

Of the 15 students identified earlier from the LASSI ratings as good learners: 9 had exam scores in the highest range; 4 had exam scores in the lowest range: and 2 had exam scores that fell within the omitted range of 61 and 63.5 Of the 15 students identified earlier from the LASSI ratings as poor learners: 9 had exam scores in the lowest range; 4 had exam scores in the highest range; and 2 had exam scores that fell within the omitted range of 61 and 63.5. Taken together, this shows that 60% of students were consistently classed as "good" or "poor" with both reported LASSI ratings and exam scores. However, nearly 30% of the students were reportedly good learners with poor exam scores and 30% were reportedly poor learners with good exam scores. The exam scores for students in the highest range (63.5 - 71) and lowest range (52 - 60.5) are shown in Figure 2.2.

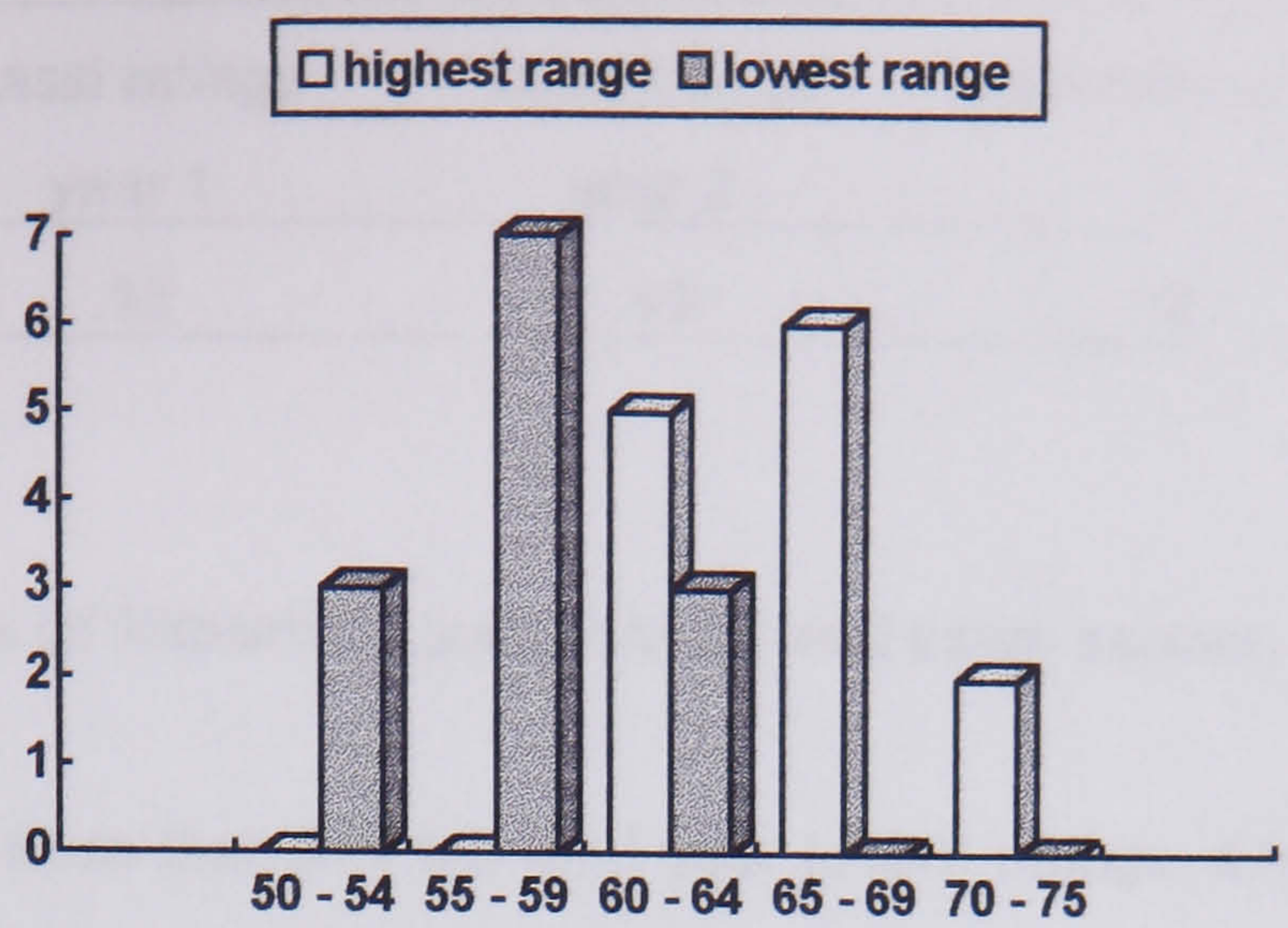


Figure 2.2 Number of students with exam scores in highest (good) and lowest (poor) range.

The students with exam scores in the highest range were classified as good learners and the students with low exam scores were classified as poor learners. As can be seen from Figure 2.2, good students had higher exam scores than poor students. This finding, however, is not surprising as students were categorised by exam performance. The main question of interest is whether reported ratings of learning from the LASSI can discriminate students with high exam scores from students with low exam scores. To investigate this question the exam scores for students with the highest reported LASSI ratings (good learners) and the lowest reported LASSI ratings (poor learners) are shown in Figure 2.3.

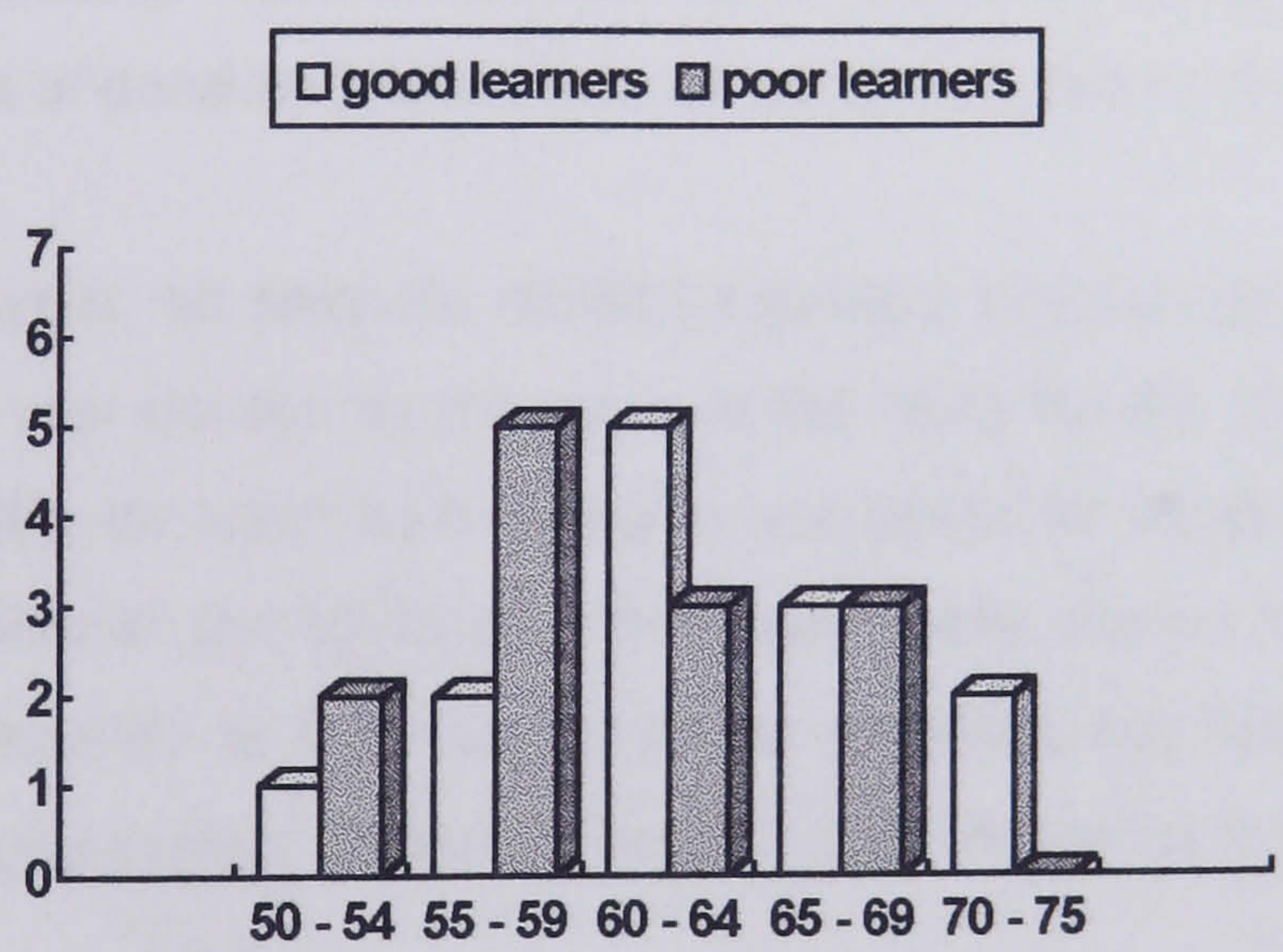


Figure 2.3 Number of good and poor learners (identified from reported LASSI ratings) with exam scores in given range.

Analysis on the data in Figure 2.3 found no significant difference between the two groups (F 2.72, df 1,25); students with the highest LASSI ratings did not have higher exam marks than students with the lowest LASSI ratings. Thus the reported ratings do not appear to distinguish students with high from students with low exam scores. In section 1.4 of the introduction, the worrying implication of Bartling's (1988) research suggested that students' perceptions of their learning ability may reflect feedback on current and past exam performance rather than their actual study habits. To explore this possibility, the first, second and third year LASSI ratings were correlated with final exam performance. This data is shown in Table 2.3.

	Lassi ratings year 1	Lassi ratings year 2	Lassi ratings year 3
exam scores	.16	.19	.34 *

* p <.05

Table 2.3 Correlations of Reported Lassi ratings and exam scores.

The data in Table 2.3 show that only the third year LASSI ratings correlated significantly with exam scores. These findings - although crude - indicate that Bartling's concerns may be well founded; students' perceptions of their learning ability may be strongly influenced by feedback on current and past academic performances. More detailed research is needed before such conclusions can be drawn. However, the finding that reported LASSI ratings did not distinguish good from poor students in terms of exam performance; and the implication that reported LASSI ratings may merely reflect feedback on current and past academic performances, support the decision to use exam scores rather than reported LASSI ratings as a measure of learning ability in this study.

2.6 The reading experiment and summaries

Subjects. The students were originally grouped into good and poor learners as identified by the LASSI. After the students had completed all 3 years of study and taken their final examinations, 2 groups of good and poor students were identified from final exam scores.

Materials. In the first-year, all students studied cognitive psychology as part of their degree course, therefore, this was chosen as the topic of the texts for the reading experiment. The lecturer with responsibility for teaching this course was asked to recommend texts which would be familiar and unfamiliar to the students. Two texts were chosen from a current cognitive psychology textbook deemed to be familiar to the students; two texts were chosen from a second-year cognitive psychology textbook deemed to be unfamiliar to the first-year students.

In the second year 14 good and 10 poor learners continued to study cognitive psychology; one good learner studied linguistics; and 5 poor learners studied either biology, computer science, or economics. In the third year the psychology students could study different topics, 9 good and 5 poor learners chose cognitive science, 2 good and 1 poor learner chose health psychology, 2 good and 4 poor learners chose emotion and stress, and 1 good learner chose vision. In both the second and third years the lecturer with responsibility for teaching the cognitive science courses was asked to recommend four passages, two of which could be deemed to be familiar to the students since they were on the list of recommended reading, and two of which could be deemed to be unfamiliar since they were not recommended reading. Two familiar and two unfamiliar cognitive psychology texts were chosen to rule out potential effects due to the materials. The two levels of this factor are called "text version" which is explained shortly in the design section. Lecturers from non-psychology courses were asked to recommend two passages - one deemed to be familiar and one deemed to be unfamiliar. Each familiar text was matched with an unfamiliar text for word length and for reading age. The Gunning Fog index was adopted as an indicator of readability and calculates a rating based on the overall sentence length and the number of words per sentence that contain more than one syllable. Sentences with multiple syllable words are rated as more difficult to read (Reece & Walker, 1992). For all texts, the Fog index ranged between 15.0 and 18.8 years, and the word length ranged between 530 and 552 words, although the matched familiar and unfamiliar texts given to each student were mostly within 1 year on the FOG Index. The word lengths and Fog indexes for all psychology and non-psychology texts can be found in the appendix, tables A2.2 and A 2.3 respectively. Copies of all the texts can be found in the appendix, table A2.4.

Design and Procedure Analysis of the verbal protocols was carried out in three different ways. First, analysis was carried out with good and poor learners identified by exam performance and involved 3 factors in a 2 (exam performance) x 3 (year of study) x 2 (text familiarity) design with repeated measures on the last two factors. The 2 levels of *exam performance* were good and poor learners (identified by final exam scores). The 3 levels of *year of study* specified whether the students were in their first, second or third year. The 2 levels of *text familiarity* were whether the text was familiar or unfamiliar.

Second, analysis was carried out on good and poor learners identified by reported LASSI ratings. This involved 3 factors in a 2 (LASSI ratings) x 3 (year of study) x 2 (text familiarity) design with repeated measures on the last 2 factors. The 2 levels of *LASSI ratings* were good and poor learners (identified from reported LASSI ratings). Again the 3 levels of *year of study* specified whether the subjects were in their first, second or third year and the 2 levels of *text familiarity* were whether the text was familiar or unfamiliar. As exam performance is considered the critical measure of learning, analysis with exam performance is reported in this chapter. Analysis with reported ratings as the measure of learning is included in the appendix, table A2.5, and the two measures of learning are compared and contrasted.

Third, precautions were taken to check for potential effects due to the materials. Because of the large number of texts used in this experiment it seemed unlikely that the texts themselves would affect the outcomes. However, as a precaution analysis of the materials was undertaken. Matching the texts for word length, readability and familiarity or unfamiliarity was a labour intensive exercise, and testing for any effects of materials required two versions of each text. The decision was therefore taken to use cognitive psychology texts to test for effects of materials because most students studied this topic. Furthermore, as different numbers of students studied cognitive psychology each year, analysis of the materials was carried out separately for each year Two familiar and two unfamiliar cognitive psychology texts were chosen for the first, second and third year experiments. Half of the cognitive psychology students were randomly given "version 1" familiar and unfamiliar texts while the remaining half were randomly given "version 2" familiar and unfamiliar texts. The order of presentation of familiar and unfamiliar texts was counterbalanced.

The LASSI was completed by 169 students at the beginning of their first year in a single session during normal class time. The experimenter explained the rating scales and required responses, after which the students completed the questionnaire. The testing session lasted about 45 minutes. At the beginning of the second and third years LASSI's were mailed to the selected samples of good and poor learners. Instructions for completing the questionnaire were included to remind students how to make their responses. The students were asked to return the questionnaires within 4 weeks. Further prompting ensured that all questionnaires were returned by the end of the first academic term.

Final examinations were a prerequisite for all students in this study, and were held over a period of about four weeks at the end of the second and third years of study. Each exam lasted between 2 - 3 hours.

In the verbal protocol experiment, students were asked to read out loud each text, and to stop after every one or two sentences to report their thoughts. Practice texts were used until the students felt confident with the procedure, and were stopping after every one or two sentences to report their thoughts. Recall that we asked students to report any thoughts that they had - we did not attempt to specify what processes should be reported. The experimenter also prompted students who stopped thinking aloud by asking "What are you thinking of now?" or "Have you any thoughts at the moment?" Written instructions to students are shown below:

> *"Please read this text out loud. As you're reading the text out loud, stop after every one or two sentences and tell me what you are thinking at that moment. Please report any thoughts that you have, it doesn't matter what they are. Read the text to try and get a good understanding - take as much time as you like. When you have finished reading the text, I will ask you to write down the main points of the passage. The text will not be available once you have finished reading it."*

Pencils, highlight pens, and blank sheets of paper were available for use while reading. After reading each text the students were asked to rate their comprehension using a 5 point Likert-type scale ranging from 1 (very poor) to 5 (very good). Students were than asked to provide a written summary of what they thought were the main ideas of each text (described in Chapter 6). After the experiment I spent time with each student looking at their learning profiles from the LASSI, commenting on identified strengths and weaknesses. The students gave permission for these comments to be recorded and used as anecdotal evidence if appropriate. Finally, the verbal protocols were tape recorded, and then later transcribed.

Results

2.7 The scoring procedure In order to determine the range of techniques used, different categories were defined and coded. To achieve an increasingly fine-grained analysis of the think aloud protocols, different criteria were used to categorise the learners' comments. First, a crude level of coding scored the protocols for the number of utterances they contained, with an utterance defined as "a unit expressing a single idea". An utterance could vary in length from a single clause to several clauses. Utterances were often bounded by the reader pausing or by the use of a different reading strategy. An example of a section of protocol broken down into numbered utterances is shown below. This protocol is taken from a good learner reading a second year unfamiliar text:

Text Pylyshyn (1981), for instance, argues that images are epiphenomenal and not part of the functional architecture of the machine because they are 'cognitively penetrable'. That is, the way in which they govern behaviour can be influenced in a rationally explainable way by beliefs, goals, and tacit knowledge.

Protocol *I'm making an assumption that epiphenomenal means ... outside of or separate from .. or peripheral to perhaps ...... (1) these images then.. they govern behaviour in ways that can be explained (2) I haven't a clue what I'm talking about here. (3)*

Second, a finer level of coding categorised the utterances to reflect different activities used by students when reading. Utterances that described the use of reading strategies were categorised as **reading strategies**; utterances that indicated whether or not the text had been understood were categorised as **monitoring strategies**; and utterances that described the use of inferencing were categorised as **warranted inferences** (i.e. plausible in relation to the text content) or **unwarranted inferences** (i.e. not plausible in relation to the text content). . Examples of these strategies will be given shortly. No utterance was classified into more than one category.

Analyses of the verbal reports was carried out in three different ways. First, analysis of good and poor learners' verbal protocols was undertaken with three main effects, one was a between subjects effect and two were within subjects effects. The between subjects effect of **performance group** compares students with the highest and lowest exam scores. The within subjects effect of **year** compares students' performances across 3 years of study (year 1 vs. year 2 vs. year 3); while the within subjects factor of text familiarity (called **text**) compares students' performances when reading familiar and unfamiliar texts.

The second type of analysis attempted to rule out potential effects of the materials. As 36 different texts were used it seems unlikely that the materials will effect the outcomes, but it is still important to rule out the possibility. To do this two versions of each text are used, called "version 1" or "version 2" texts. With 36 texts to select and match for word length and readability, and for familiarity or unfamiliarity, it would have been very time consuming to double this number. Therefore cognitive psychology was chosen as the topic to check for any effects of materials because most students taking part in this experiment studied this topic. Also because different numbers of students studied cognitive psychology each year, separate analysis was undertaken for each year. Analysis of the effects of materials therefore had three main effects; two were between subjects effects and one was a within subjects effect. As before the between subjects effect of **performance group** compares students with the highest and lowest exam scores. The between subjects effect of **text version** compares performances with version 1 or version 2 cognitive psychology texts. The within subjects effect of **text** (familiarity) compares performances reading familiar and unfamiliar texts. Because analysis was carried out for each year separately, the within subjects effect of year was redundant. The results of this analysis are reported at the end of this chapter.

The third type of analysis was carried out on students identified by reported LASSI ratings. This is identical to the analysis of good and poor students identified by exam scores, but the between subjects effect of performance group is replaced with the between subjects effect of **learning group** which compares students with the highest and lowest reported LASSI scores. The 2 within subjects effects of **year** and **text** (familiarity) are again included. Because exam performance is deemed to be a better measure of learning, analysis based on reported LASSI ratings are reported in the appendix (table A2.5) where effects of performance group and learning group are compared.

All of the results reported in this chapter refer to good and poor students identified by their *final median examination scores.* When describing differences between the two groups the term "*good and poor learners*" is used to emphasize this distinction. Only significant and marginal effects and interactions are reported. The presentation of results is ordered as follows. Section 2.8 describes the basic data (reading times and utterances); section 2.9 describes the number and type of strategies used; section 2.10 describes the number and type of monitoring strategies used; section 2.11 describes the control of strategy use; section 2.12 describes the number and type of inferences used; section 2.13 describes ratings of comprehension of the texts; and section 2.14 describes whether the materials themselves affected the outcomes with the factor of text version.

2.8 Basic data The mean **reading times** (which included time taken for the verbal reports) and the mean number of **utterances** are shown in Figures 2.4 and 2.5 respectively. Analysis of variance was carried out on the data in these figures and the outcomes are shown in Table 2.4. Analysis of variance tables of these measures, together with tables of all other measures are given in the appendices, table A2.6 - A2.41.

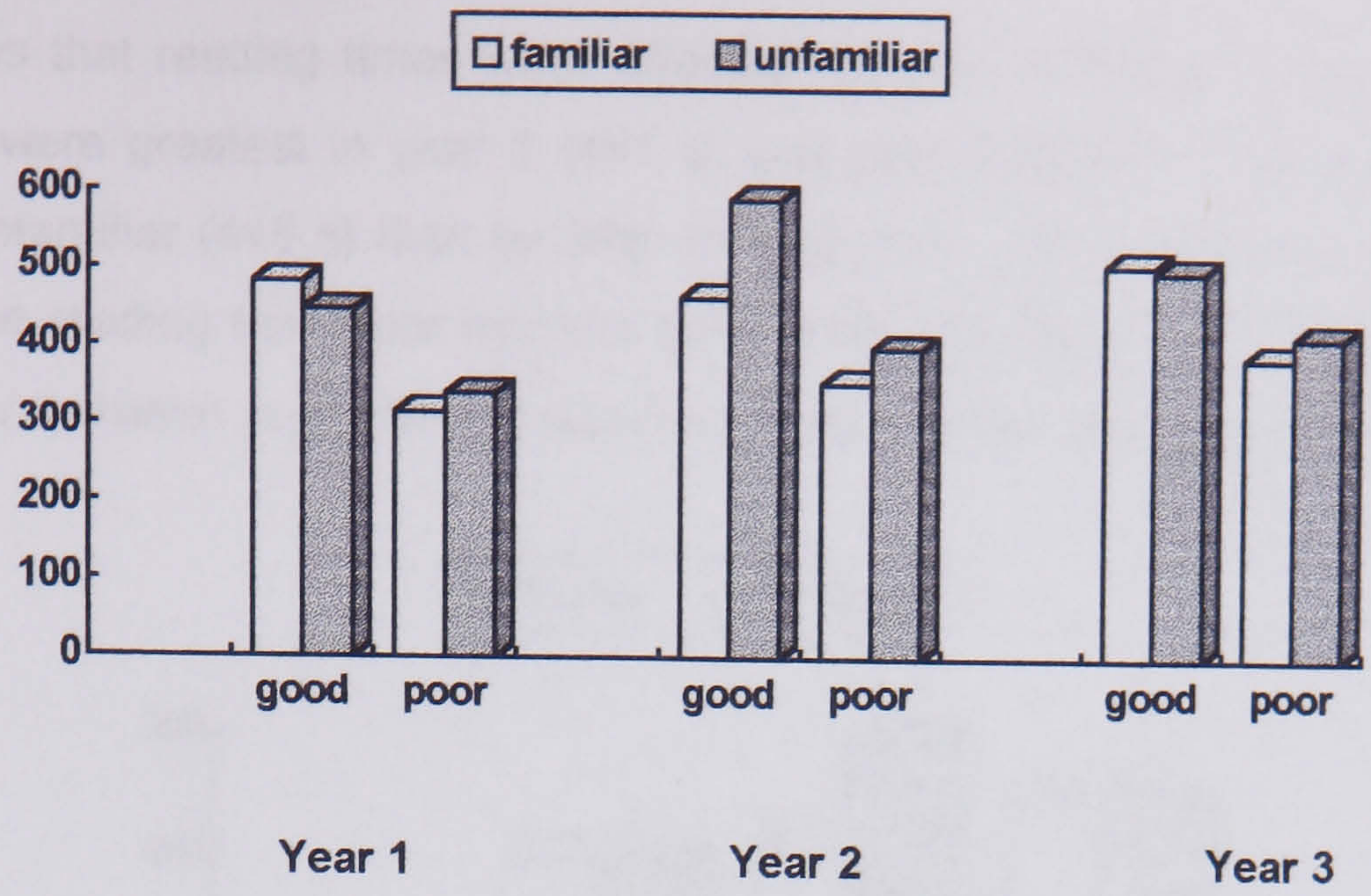


Figure 2.4 Mean reading times (in seconds) for good and poor learners.

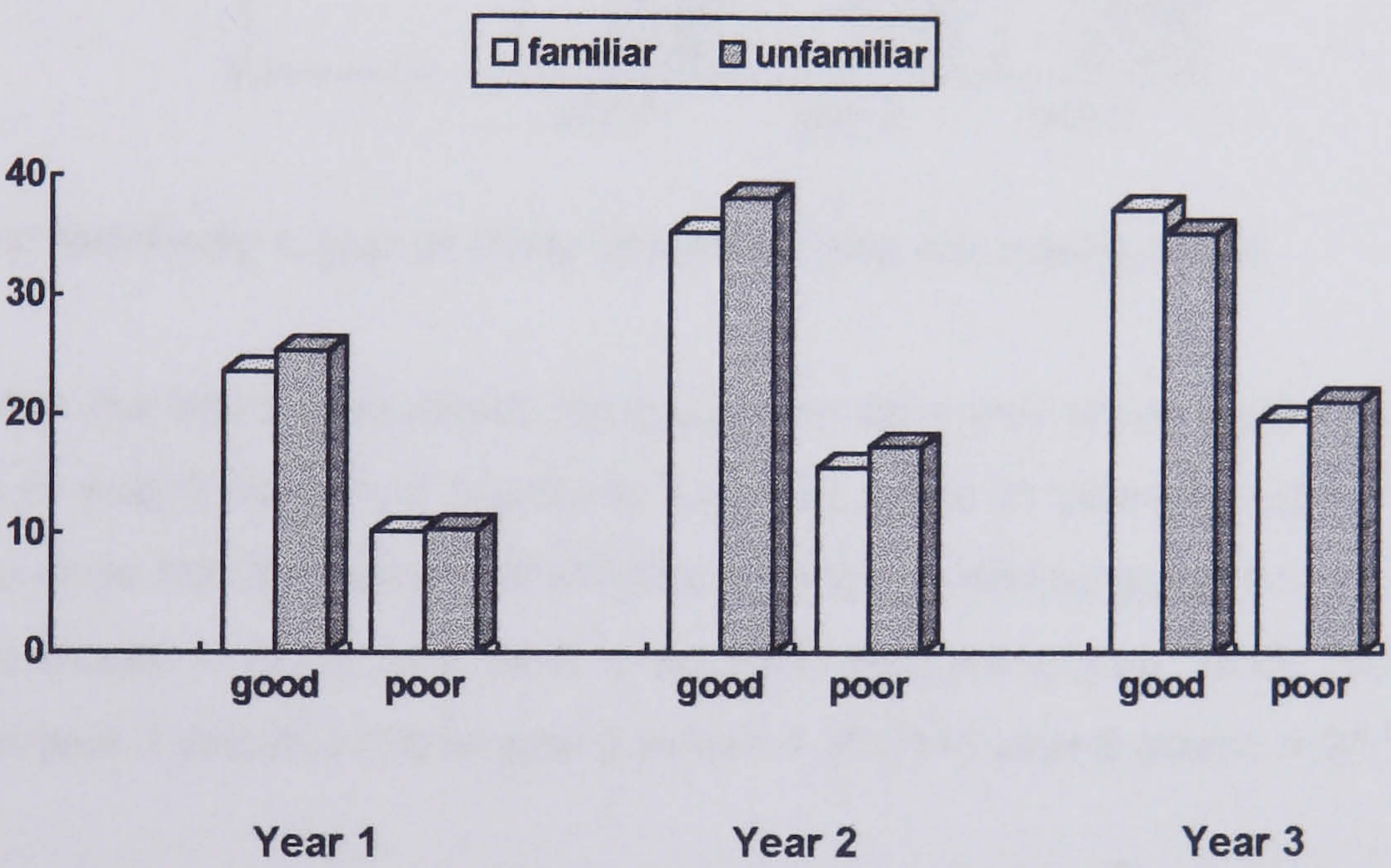


Figure 2.5 Mean number of utterances for good and poor learners.

Source of variation	df	F	p
reading times			
good vs poor	1,24	3.66	.06
year	2,48	3.52	.04
text	1,24	5.36	.03
2-way year x text	2,48	3.36	.05
utterances			
good vs poor	1,24	7.65	.01
year	2,48	8.90	.001
text	1,24	0.81	ns

Table 2.4 Outcomes of analyses on reading times for good and poor learners.

Table 2.4 shows that reading times were affected by year of study, and by text familiarity. Reading times were greatest in year 2 (451 s) and year 3 (453 s) than year 1 (396 s) and greatest with unfamiliar (448 s) than familiar (418 s) texts. Good learners (498 s) tended to spend more time reading than poor learners (369 s) but this effect just missed significance. A 2-way interaction between year and text was found and is shown in Figure 2.6.

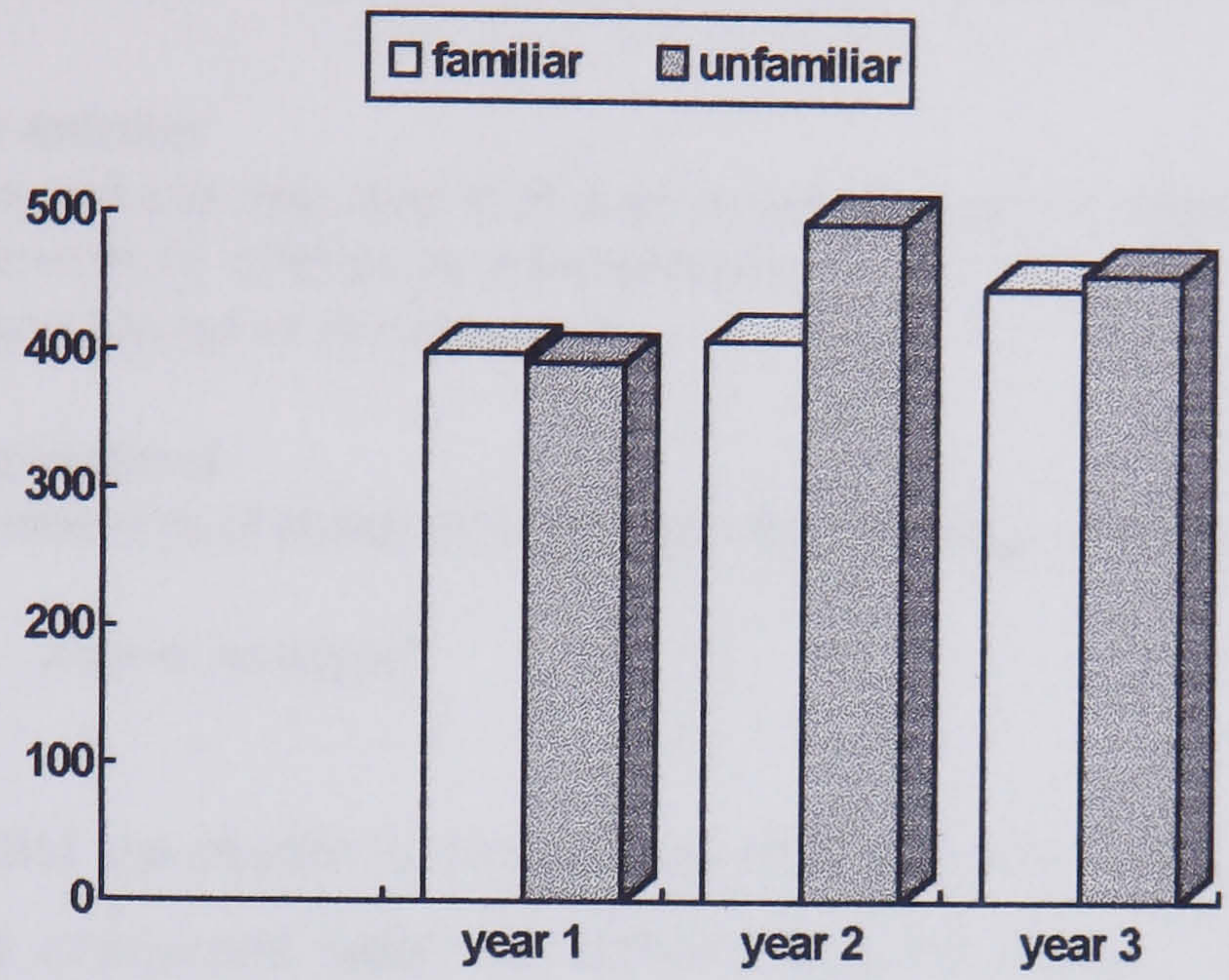


Figure 2.6 Text familiarity x year of study interaction with the reading times.

Figure 2.6 shows the interaction arises because more time was spent reading unfamiliar than familiar texts in year 2 while text familiarity had little effect in years 1 and 3. Table 2.4 and Figure 2.5 also show that the number of utterances was affected by group and by year of study. Good learners (mean = 32.6) had more than poor learners (mean 15.8); and the number increased from year 1 (mean 17.4) to year 2 (mean = 26.7) to year 3 (mean = 28.5).

2.9 Comprehension Strategies Several comprehension strategies were identified in the protocols. The most frequently used strategy was re-reading the text. Less frequently used strategies were asking questions or setting watchers; recalling prior learning situations; "taking the text in"; and challenging the author's views. A group of strategies used infrequently in the first year verbal protocols experiment were grouped together and categorised as "other" strategies and included: identifying and/or defining unfamiliar terms; linking different text segments; making references to real life situations; reading ahead; and identifying main points in the text. The strategies of making inferences and restatement were used far more frequently than the above strategies and will be analysed and reported separately in section 2.12. Definitions and examples of each comprehension strategy are now given.

(1) Reread Students frequently stopped reading the text to re-read particular segments. This strategy was recognised when students stated that they were going to re-read the text, or when they could be heard re-reading the text. If students appeared to be re-reading silently, they were prompted to say aloud what they were thinking.

(2) Ask Question or set a watcher Asking questions and setting watchers are strategies that question the text. Bereiter & Bird (1985) defined setting watchers as "*a response to missing information that the reader expected later portions of the text to supply*"; and defined asking questions as "*expressing dissatisfaction with the present state of information*". The main difference between watchers and questions is that the former are concerned with **anticipation** but the latter with **dissatisfaction**. Two examples from the students' protocols are given below.

Example (a): setting a watcher
Text: The idea is that a pronoun may drop from a given sentence only if certain important aspects of its reference can be recovered from other parts of the sentence.
"*Is this the verb? it's going to tell us this I'm sure.*"

Example (b): asking questions
Text: There are many examples of constraints based on the meanings of words that appear independent of context.
"*Constraints of what? .. it's just so vague*".

Example (a) shows that the reader is anticipating what the author will say while example (b) shows the reader is concerned with the author's lack of clarity. However, most of the questioning in this study concerned students testing their understanding as the following examples illustrate.

Example (c): questioning to test understanding
Text: The results showed that for births weighing up to 1500 grams, place of delivery made no significant difference to the chance of surviving the neonatal period. At all heavier weights this chance was significantly less if delivery took place in a hospital.
"*What chance was less?*".
The reader re-read the first sentence again.
"*Ah yeah the chance of surviving.*

Example (d): questioning to test understanding
Text: In the 1958 survey, the perinatal mortality rates for births with gestations of less than 38 weeks and for births weighing less than 2500 grams were much the highest for actual deliveries in hospital and were highest also for hospital-booked deliveries.
"*So is that both hospitals?*
The reader re-read the sentence again
"*Yeah, both hospitals.*"

Most of the questions concerned testing understanding with only a small number anticipating the text or expressing dissatisfaction. Taking this into account, and the fact that distinguishing anticipation from dissatisfaction was often subjective, all instances of questioning were grouped into one category called '**questions**'.

(3) Recall of prior learning Students frequently referred to previous learning situations when reading. This mostly took the form of saying that the material was familiar and then recalling where they had first encountered the topic. Although the topic of the material could be familiar, the content of the text should not. The following comments illustrate this strategy.

"*I already knew that*"

"This sound familiar to the lectures."
"This is really familiar 'cos I've done this before."
"This is the kind of thing I've been doing in the experimental classes."

(4) Taking the text in This strategy is very similar to the "crunching strategy" identified by Johnston & Afflerbach (1985) whereby the reader "*stops input and rather passively waits for an automatic process to operate on the information in working memory .. which often allows further progress towards main idea construction.*" (pp 213). Example (e) illustrates this procedure.

Example (e):
Text Detailed analysis of these patients has suggested that there are actually a number of somewhat different processes which can be used to permit repetition of a spoken word.
student sits silently for a while and then says "I'm just really taking that information in."

(5) Challenge the author Students usually challenged the author by reacting critically to the text; by expressing their own beliefs and attitudes towards a topic; or by giving alternative ideas to those of the author. Examples (f) and (g) illustrate this critical reading strategy.

Example (f):
Text Understanding and consolidation need to occur hand in hand, but there is a constant danger that what gets consolidated is material that has not been properly understood. This will happen whenever prior knowledge has not been activated during learning.
"But you might not have any prior knowledge for a subject."

Example (g):
Text: The portraits of Chaucer's pilgrims nevertheless owe a great deal to medieval traditions of literary portraiture, including the series of allegorical descriptions in *The Romaunt of the Rose*. The hypocritical friar, the hunting monk, the thieving miller and others are familiar types in medieval *estates satire*, in which representatives of various classes and occupations are portrayed with a satiric emphasis on the vices peculiar to their stations in life.
"But I think he also added quite a different dimension .. to the Romaunt .. they're not just types.

(6) Strategies used infrequently and categorised together as "other" strategies As stated earlier the most infrequently used strategies in the first-year verbal protocols experiment were grouped together and categorised as "other" strategies. These strategies were identifying and/or defining unfamiliar terms; linking text segments; reading ahead; real life references and identifying important points.

(i) Identify and Define unfamiliar or unusual terms Students identified a word or term as unfamiliar or unusual and sometimes attempted a definition. Example (h) illustrates these strategies.

Example (h):
Text The crucial findings related to the tapping rates of the two messages. According to Treisman's theory, there should be attenuated analysis of the non shadowed message
"Mmn .. attenuated analysis .... " **(identifies unfamiliar term)** .... *so that means it's sort of turned down, so you don't hear so much."* (**attempts to define the term**).

(ii) Link text segments Example (i) shows a reader linking ideas from two different sentences in the text.

Example (i):
Text When Aristotle invented logic his method was to determine which pairs of syllogistic premises yielded valid conclusion. (Sentence 8) A major advantage of natural mental models over other, more sophisticated forms of representation such as Euler Circles, Venn Diagrams and even the first-order predicate calculus, is that they can represent the content of any sentences for which the truth conditions are known. (Sentence 15).
"That bit earlier about how Aristotle did his theorising about logic (sentence 8) *I can see how that relates to the more natural mental models and what he's talking about there."* (sentence 15)

(iii) Read ahead This strategy was used when students decided to put to one-side a point that was confusing or lacked clarity in the hope that the author will clarify this point later in the text. Example (j) illustrates this strategy.

Example (j):
Text In support of their suggestion they produced psychophysical evidence, and cited physiological evidence of Enroth-Cugell and Robson (1966) that the contrast-sensitivity functions of individual ganglion cells of the cat are narrower than the overall contrast-sensitivity function. (familiar vision text)

" Individual ganglion cells are narrower than the overall ones .... er ... I'll come back to that ."

(iv) Real life references Students occasionally reflect on what they would do in "real-life" situations when reading texts rather than reading the text in an experimental setting. Example (k) illustrates this strategy.

Example (k):
Text In fact, the shadowed or attended message showed a very large advantage in detection rates over the non-shadowed message, with the detection rates being 87% and 8% respectively.
"That's something I'd actually try to memorise ... if I was doing an exam."

(v) Identify main points This strategy was used when students identified something as an important part of the text. Example (l) illustrates this strategy.

Example (l):
Text: These representations form the episodic memory for the text. They can be thought of as being held in a distinct episodic store that therefore contains all the information stated in the text together with additional (inferred) schema-based information.
"Yeah this .. mention of inferences ... it seems to be quite important from what they're saying."

The number and type of strategies used are shown overleaf in Figure 2.7. The outcomes of analysis of variance carried out on these data is shown in Table 2.5. Analysis revealed that good learners (mean 1.2) used a greater number of strategies than poor learners (mean 0.60); and that re-reading was more common than any other strategy. Two 2- way interactions and one 3-way interaction were found which culminate in a 4-way group x year x text x type of strategy interaction. However, with the exception of the group x strategy interaction, individual comparisons (see Table 2.5) reveal the interactions are due to good learners only.

Figure 2.7 Comprehension strategies used by good and poor learners.

rr reread; **q** question; **l** recall prior learning; **ti** take in text; **ca** challenge author; **o** others

source of variation	df	F	p			
comprehension strategies						
good vs poor	1,24	5.26	.03			
year	2,48	2.55	.09			
text	1,24	1.28	ns			
type of strategy	5,120	21.55	.000			
2-way group x strategy	5,120	3.13	.01			
2-way text x strategy	5,120	3.00	.01			
3-way group x year x text	2,48	4.01	.02			
4-way group x year x text x strategy	10,240	2.42	.01			
Individual Comparisons	**good learners**			**poor learners**		
year x text	2,24	4.27	.03	2,24	0.44	ns
text x strategy	5,60	2.30	.05	5,60	0.89	ns
year x text x strategy	10,120	1.84	.06	10,120	1.72	.09

Table 2.5 Outcome of analysis of comprehension strategies for good and poor learners.

The group by strategy interaction is shown in Figure 2.8.

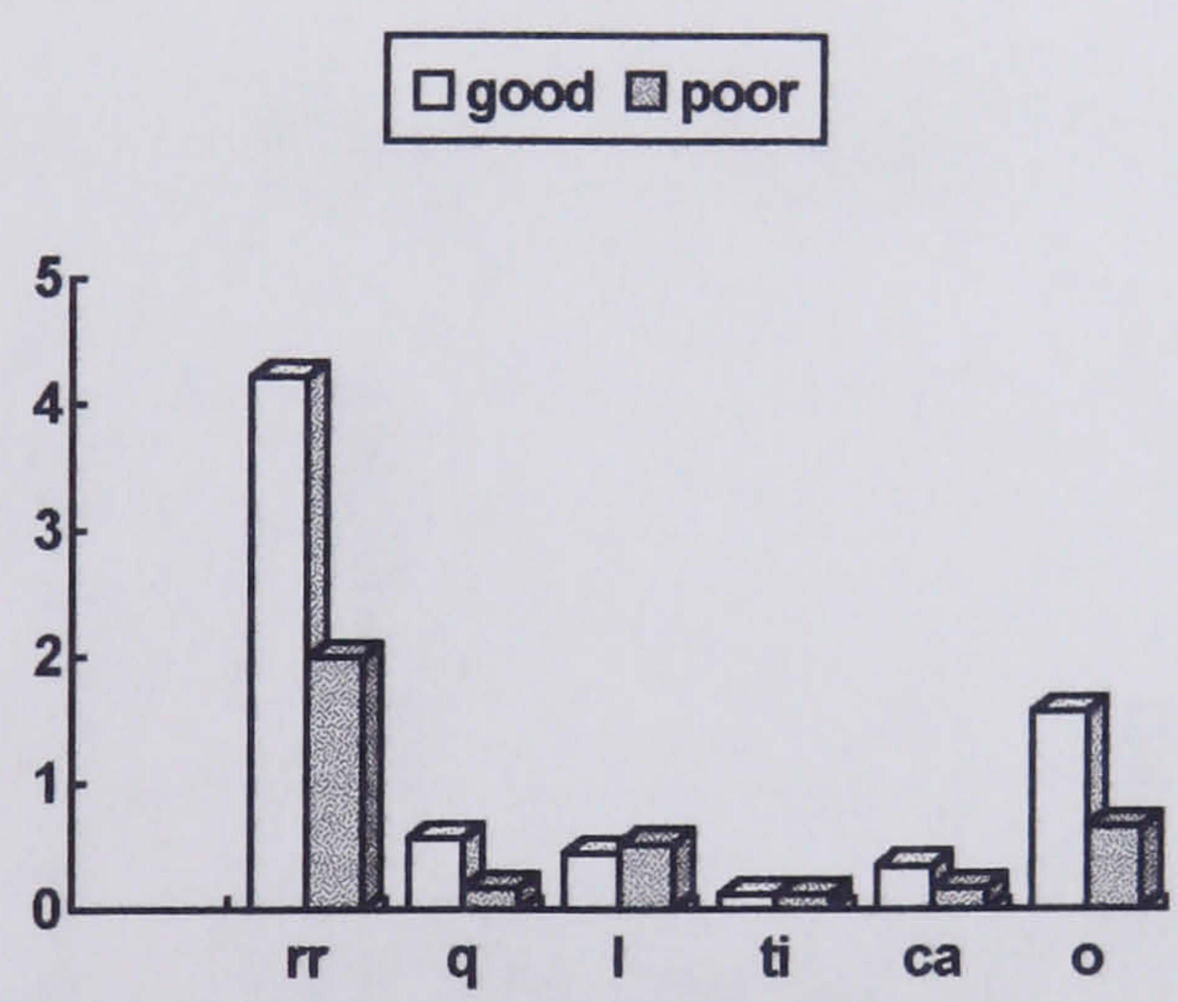


Figure 2.8 Group by type of comprehension strategy interaction for good and poor learners.

rr reread; **q** question; **l** recall prior learning; **ti** take in text; **ca** challenge author; **o** others

Figure 2.8 shows the interaction arises because good learners used re-reading and other strategies more often than poor learners. Individual comparisons revealed that with good learners, a 2-way year x text interaction, and a 2-way text x strategy interaction culminate in a 3-way year x text x strategy interaction which just misses significance (p .06). These 3 interactions are shown in Figures 2.9, 2.10 and 2.11 respectively.

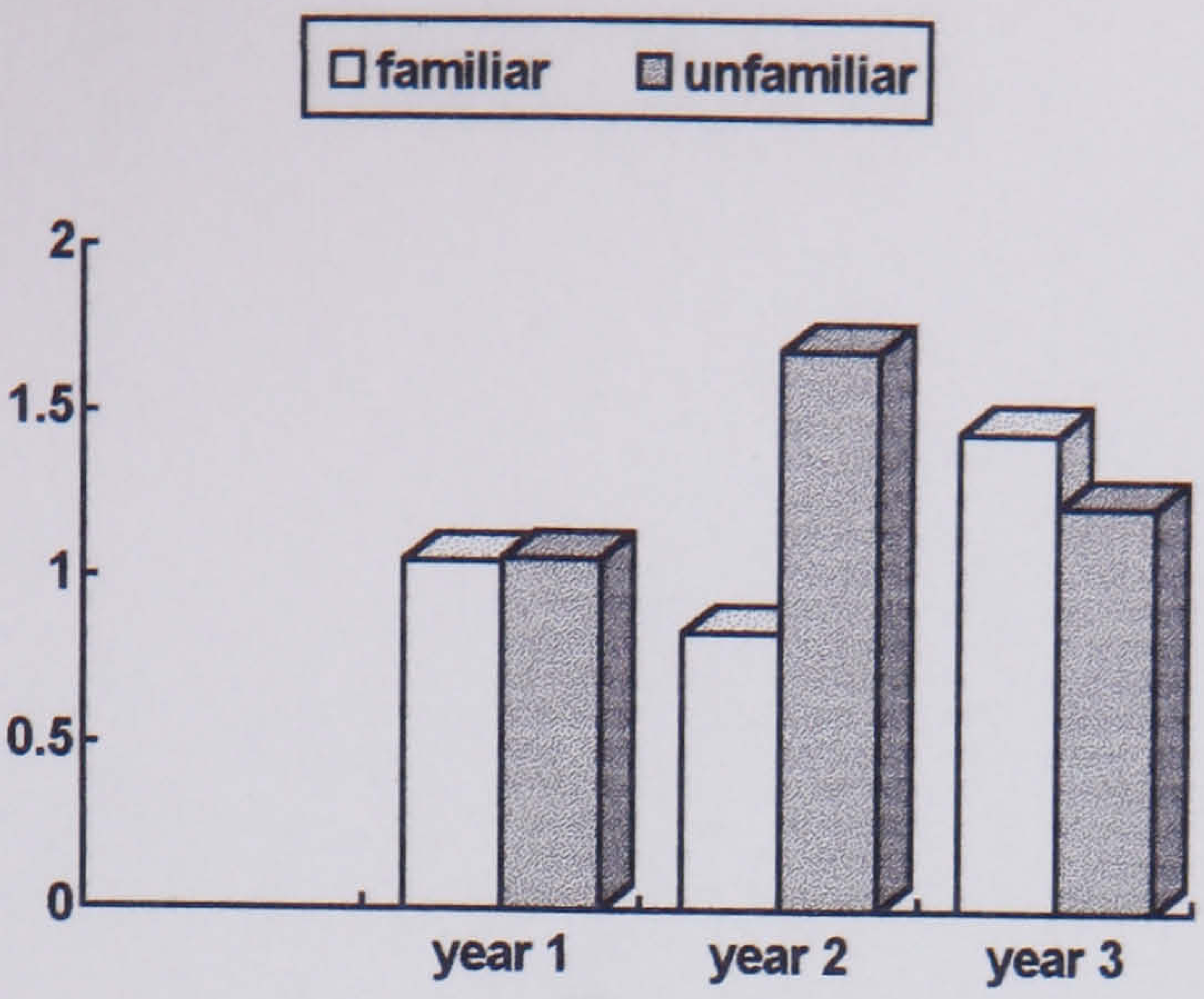
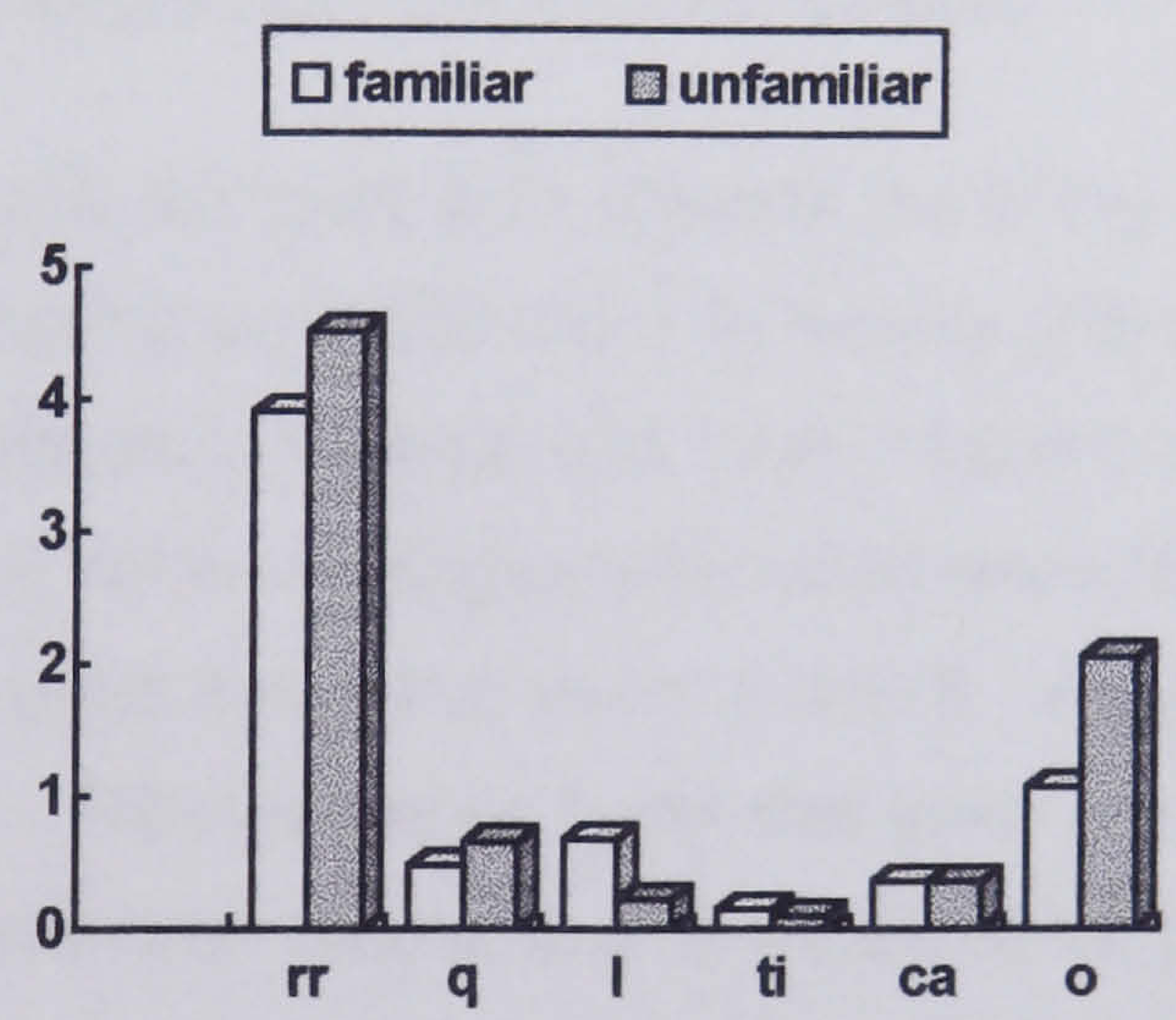


Figure 2.9 Year x text interaction with good learners strategy use.

Figure 2.9 shows the year x text interaction arises because more strategies were used with unfamiliar than familiar texts in year 2, but more were used with familiar than unfamiliar texts in year 3.



rr reread; **q** question; **l** recall prior learning; **ti** take in text; **ca** challenge author; **o** others

Figure 2.10 Text x type of strategy interaction for good learners.

The text by strategy interaction in Figure 2.10 arises because re-reading and "other" strategies were both used more often with unfamiliar texts while, to a lesser extent, recalling prior learning was used more often with familiar texts. The marginal 3-way year x text x strategy interaction is shown in Figure 2.11.

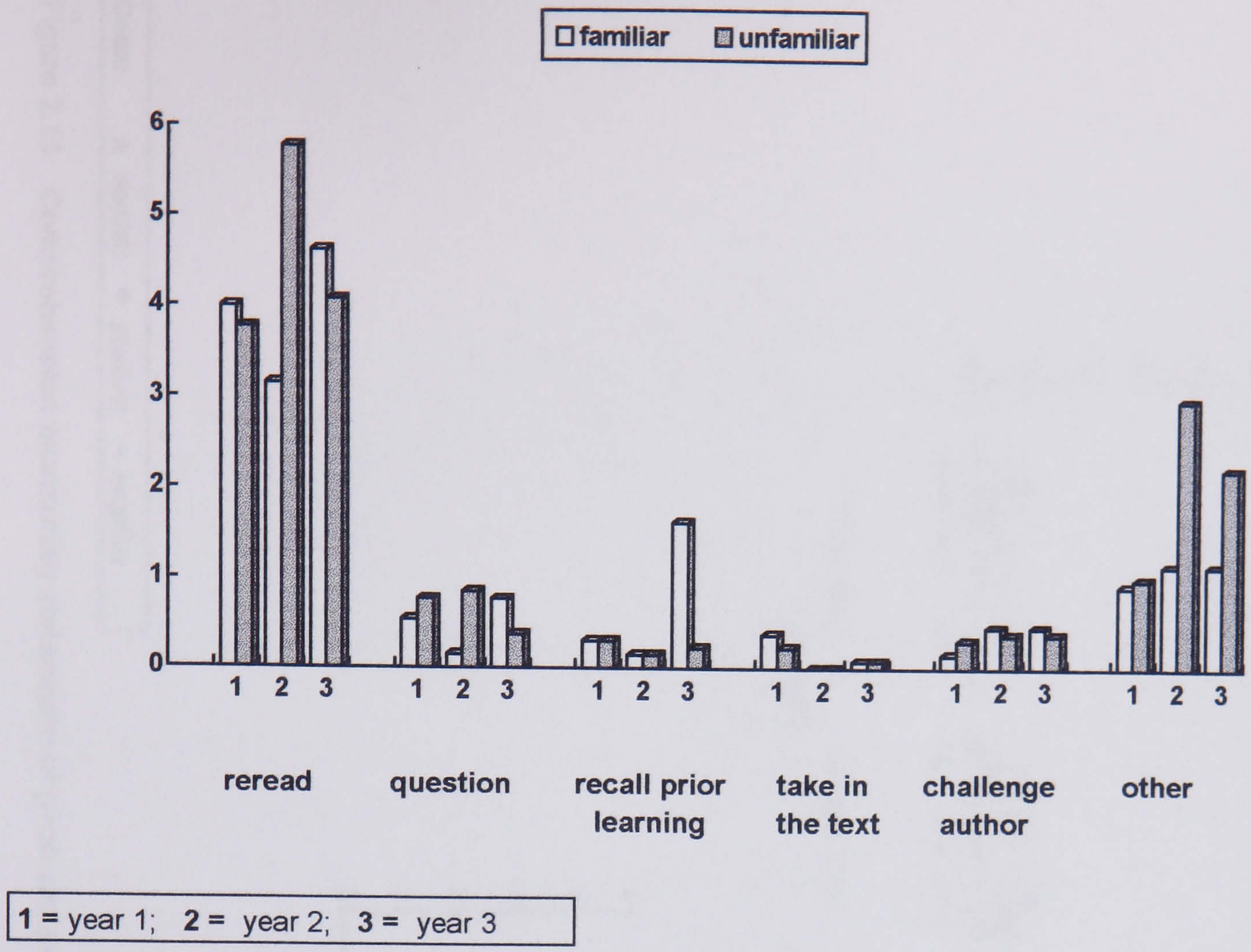
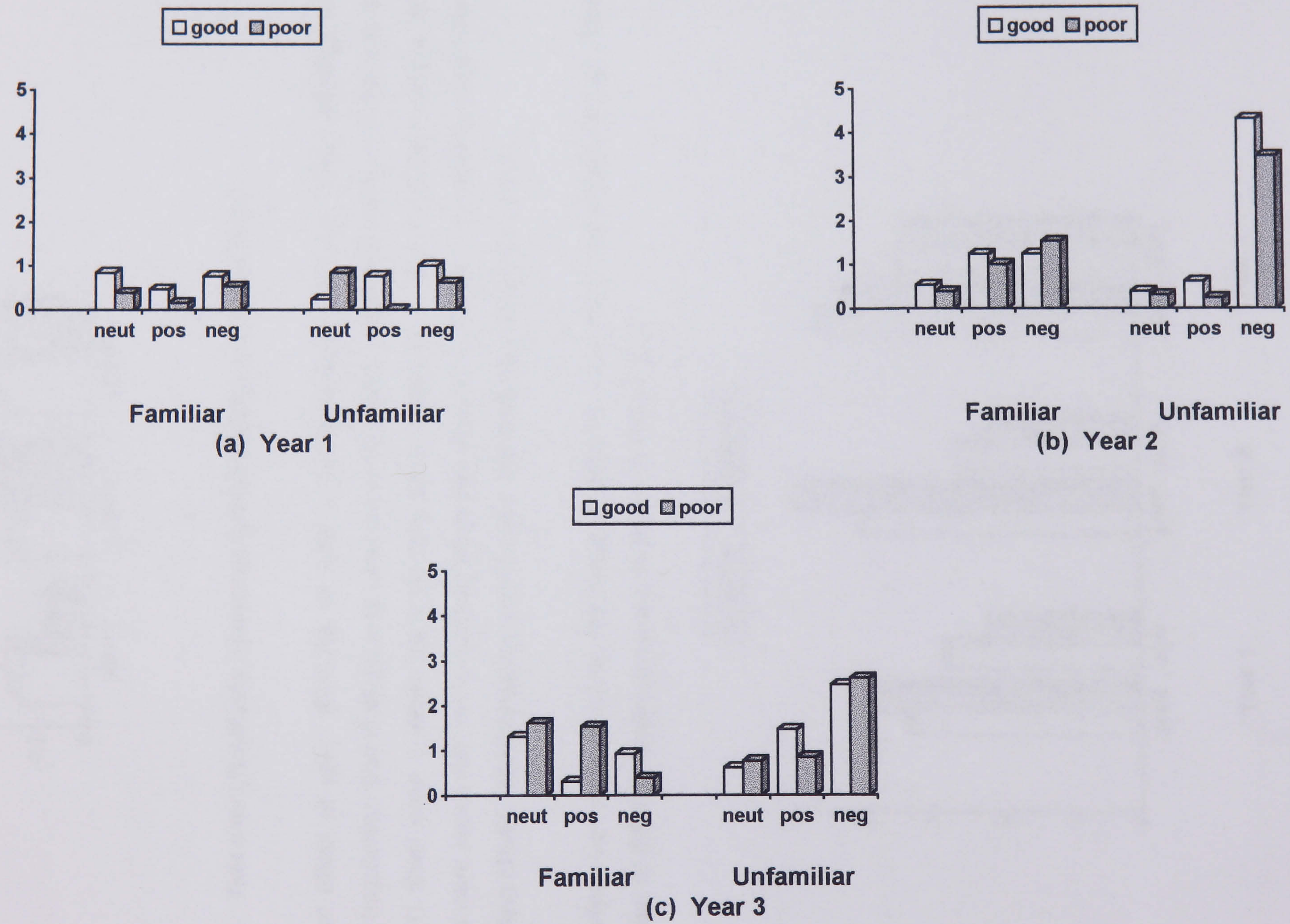


Figure 2.11 Year x text x strategy interaction for good learners.

The marginal 3-way interaction in Figure 2.11 confines the 2-way interactions described above in the following ways: re-reading was used more frequently with unfamiliar than familiar texts but only in year 2; recalling prior learning was more frequent with familiar than unfamiliar texts but only in year 3; and "other" strategies were used more frequently with unfamiliar than familiar texts but this was most marked in years 2 and 3. Analysis was then carried out to confirm these conclusions. Related t-tests found that good learners: used re-reading more often with the year 2 unfamiliar than familiar test ($t = 2.21$, df 12, $p<.05$); recalled prior learning more frequently with the year 3 familiar than unfamiliar text ($t = 2.37$, df 12, $p>.05$); and used other strategies more frequently with unfamiliar than familiar text in year 2 ($t = 2.14$, df 12, p.05) but not in year 3 ($t < 1$).

To find out which of the "other" strategies were used more frequently in year 2, further analysis was undertaken. The mean number of "other" strategies used when reading is shown in Figure 2.12 overleaf. Individual analysis on each of the strategies in Figure 2.12 found significant results with identifying unfamiliar terms and linking text segments. A year x text interaction ($F=3.43$, df 2,48, $p <.05$) with identifying unfamiliar terms is shown in Figure 2.13. This interaction arises because this strategy was used more frequently with familiar texts in year 1, but with unfamiliar texts in years 2 and 3 - particularly in year 2. Thus the earlier finding that "other" strategies were used more frequently with the year 2 unfamiliar texts can now be confined to the strategy of identifying unfamiliar terms.



Code:	n neutral;	+ positive;	- negative

Figure 2.15 Comprehension monitoring statements of good and poor learners.

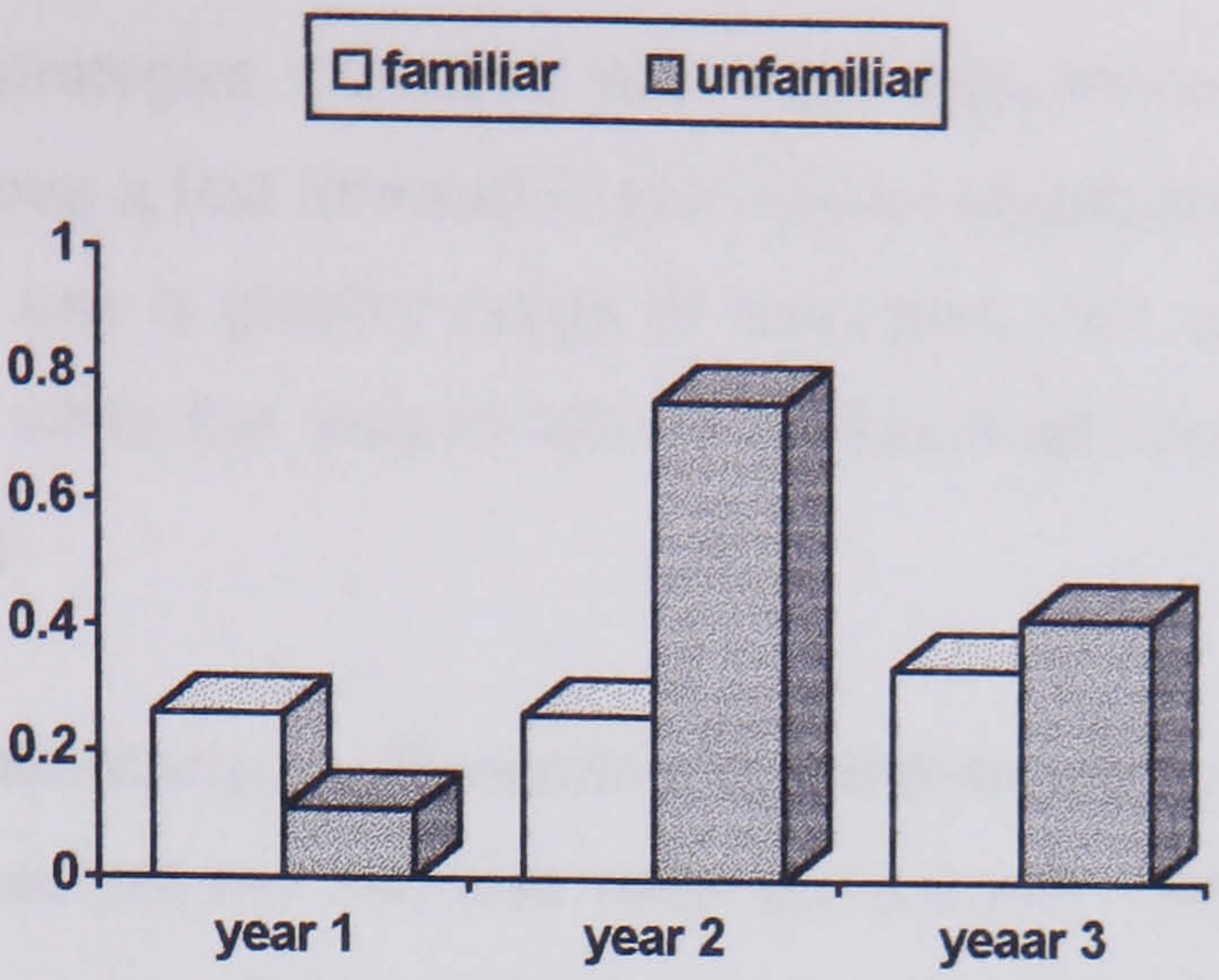


Figure 2.13 Year x text familiarity interaction with identifying unfamiliar terms

A significant effect of year (F=3.99, df 2,48 p<.03) was found with the "other" strategy of linking text segments; this strategy was used more frequently in years 2 (mean = 0.26) and 3 (mean 0.21) than year 1 when no instances were observed. No significant effects or interactions were found with the remaining strategies classed as "other"; i.e. defining unfamiliar terms, reading ahead, identifying the main points; and making real life references.

Finally, analysis was carried out on the range of different strategies used when reading. The mean number of different strategies used is shown in Figure 2.14.

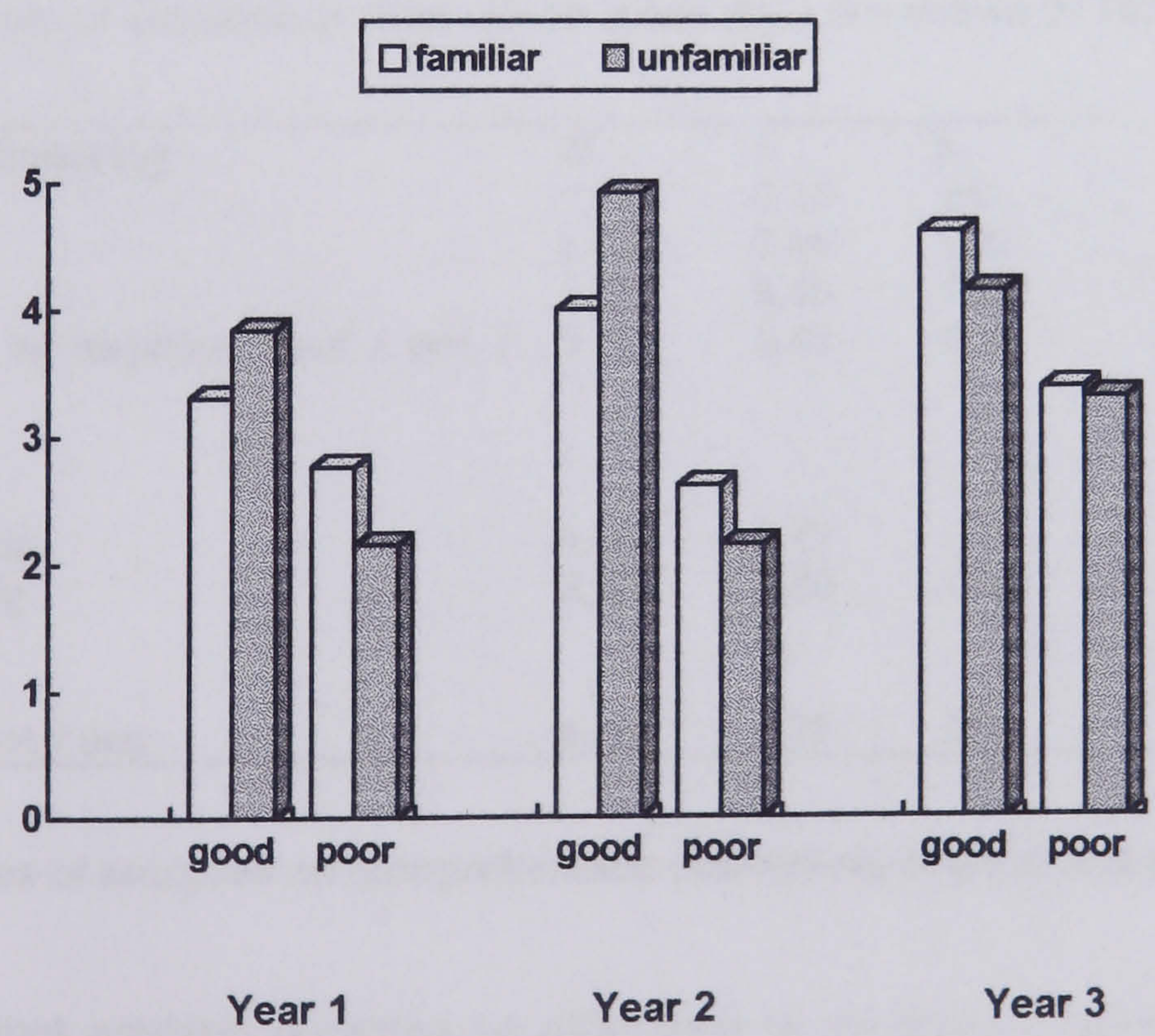


Figure 2.14 Number of different strategies used by good and poor learners.

Analysis on the data in Figure 2.14 revealed a significant difference between the 2 groups (F=7.89, df 1,24, p<.01) and between the 3 years (F=4.27, df 2,48, p.02). Good learners (mean 4.1) used a greater number of different strategies than poor learners (mean 2.7); and the number of different strategies increased with study experience (mean year 1= 3.0, year 2=3.4, year 3=3.8). A group x text interaction just missed significance (F=3.70, df 1,24, p.06); good learners tended to use a greater range of strategies with unfamiliar (mean 4.3) than familiar texts (mean 3.9) while the reverse trend was found with poor learners (familiar mean 2.9, unfamiliar mean 2.5).

2.10 Comprehension Monitoring Monitoring statements were categorised as utterances which indicated whether or not the text had been understood. Monitoring statements were categorised as positive (i.e. a reader indicates he or she understands the text); negative (i.e. a reader indicates he or she does not understand the text); or neutral (a reader shows only general awareness of performance). Monitoring statements were initially categorised as general (i.e. monitored comprehension of text in general terms) or specific (i.e. monitored comprehension of specific ideas in the text). Analysis found a much greater amount of general (0.9) rather than specific monitoring (0.1) so this factor was collapsed. Examples of monitoring statements are given below.

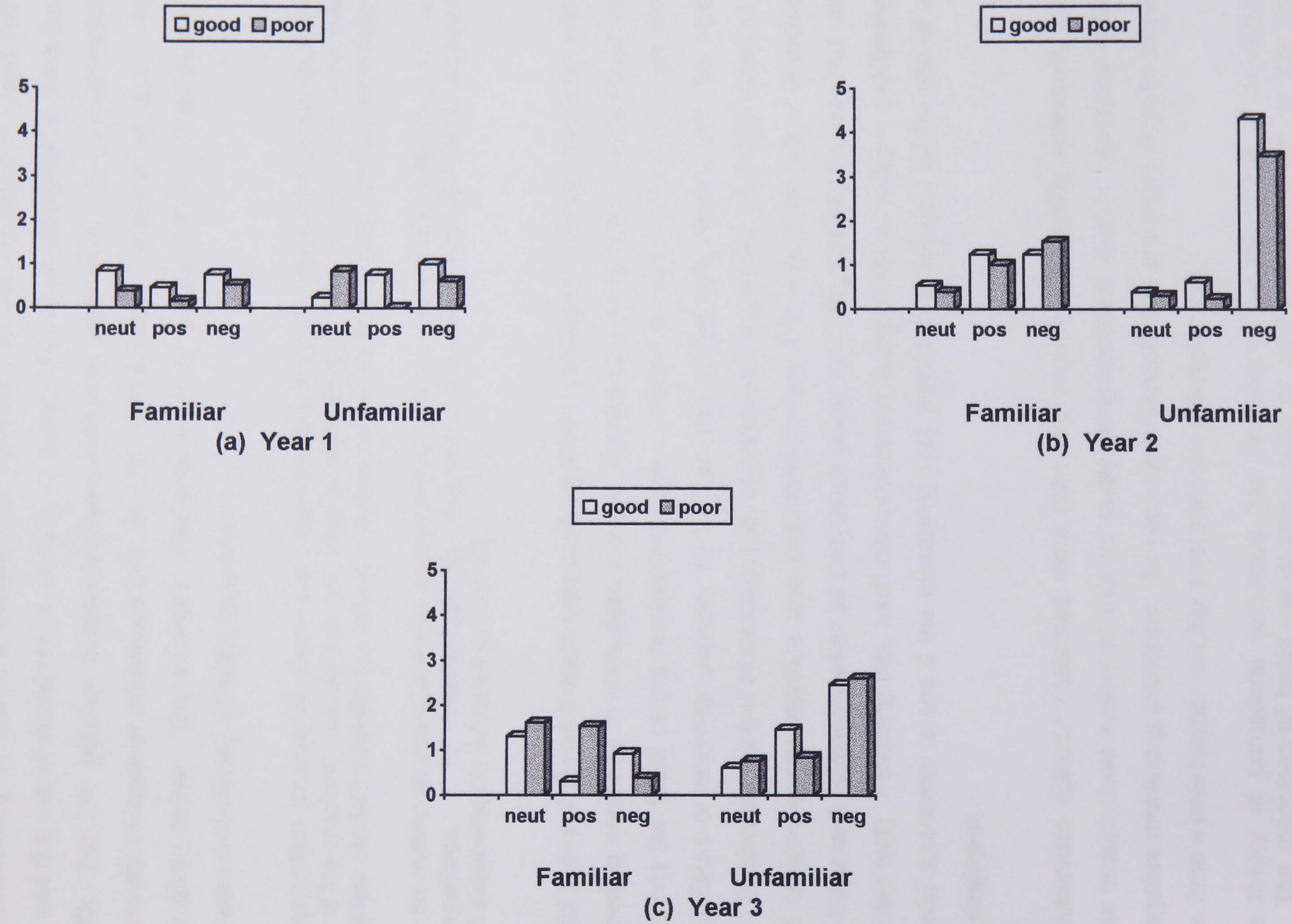
Text. Apart from their emotive use as swear words, they (obscene words) are so redolent of the things they name that even adults are pray to confusing the name for the thing.
Negative monitoring *I don't understand that sentence.* (good learner)
Positive monitoring *I get the part about their emotive use as swear words.*

The number and type of monitoring statements are shown in Figure 2.15 overleaf. The outcomes of analysis of variance carried out on these data are shown in Table 2.6 below.

comprehension monitoring	df	F	p
good vs. poor	1,24	0.15	ns
year	2,48	7.46	.002
text	1,24	5.36	.03
neutral vs positive vs negative (neut / pos / neg)	2,48	9.42	.000
2-way interactions			
year x neut / pos / neg	4,96	8.47	.000
text x neut / pos / neg	2,48	9.80	.000
3-way interactions			
year x text x neut / pos / neg	4,96	6.37	.000

Table 2.6 Outcomes of analyses on comprehension monitoring of good and poor learners.

Table 2.6 shows that analysis revealed no difference in monitoring between the two groups (F<1). However all other main effects were significant: monitoring was greater in year 2 (0.6) and year 3 (0.6) than year 1 (0.2); greater with unfamiliar (0.6) than familiar (0.4) texts; and negative monitoring (0.8) was more frequent than positive (0.3) or neutral (0.3). Table 2.6 reveals that two 2-way interactions culminate with a 3-way interaction. Inspection of Figure 2.15 shows that all these interactions are due to the greater amount of negative monitoring with the year 2 unfamiliar text.



Code:	n neutral;	+ positive;	- negative

Figure 2.15 Comprehension monitoring statements of good and poor learners.

2.11 Control of strategy use Control of strategy use - or self regulation - was assessed by identifying instances of comprehension breakdown, and then determining whether strategies were used to overcome the comprehension failure. Before describing the findings, the procedure used to measure self-regulation is described. The level of coding of *utterances*, defined earlier as single ideas, was too crude to investigate self regulation, because utterances can reflect monitoring, or use of a strategy, but not both. As self regulation involves both monitoring and the use of strategies, a category to capture this more sophisticated behaviour was needed. For this purpose **comprehension episodes** were used. A comprehension episode consists of several utterances that all refer to the same segment of text. An example is given below. This example was also used in section 2.7 to illustrate how utterances were categorised from the protocols.

Text. Pylyshyn (1981), for instance, argues that images are epiphenomenal and not part of the functional architecture of the machine because they are 'cognitively penetrable'. That is, the way in which they govern behaviour can be influenced in a rationally explainable way by beliefs, goals, and tacit knowledge.

Protocol *I'm making an assumption that epiphenomenal means ... outside of or separate from .. or peripheral to perhaps ...... (1) these images then.. they govern behaviour in ways that can be explained (2) I haven't a clue what I'm talking about here. (3)*

This protocol segment shows 3 utterances were identified. However, as all the utterances refer to the preceding sentence, it comprises a single comprehension episode. Comprehension episodes reflect the focus of the reader's attention - when the reader moves on from this episode the focus of attention changes to another part of the text, usually onto the next sentence. To analyse control of strategy use, comprehension episodes were first identified. Next, each comprehension episode was examined to see if it also contained a negative monitoring statement (defined earlier as comments which explicitly indicate a reader has not understand the text) Following this, each comprehension episode with a negative monitoring statement was examined to see if the monitoring was preceded or followed by the use of a strategy or strategies.

If a comprehension episode contained more than one negative monitoring statement, the episode was broken down further so that no single comprehension episode contained more than one negative monitoring statement. An example to illustrate this procedure is given below and is taken from a poor learner reading a second year unfamiliar text.

Text The theory of procedural semantics has implications for the status of semantic primitives. The meanings of basic spatial terms such as *right* and *left* cannot be lexically analysed in decompositional dictionary entries of the standard sort.

Episode (a) I've no idea what that means (1) .... I'll reread that again (2) .....
Episode (b) ... I'll carry on and see (3) ... 'cos I don't understand that (4)

The 4 utterances shown above comprise a single comprehension episode. These utterances were categorised as (1) negative monitoring statement; (2) re-read; (3) read ahead; (4) negative monitoring statement. Because this single comprehension episode contains two negative monitoring statements, it was divided into episode (a) and episode (b). Episode a contains a negative monitoring statement and the strategy of re-reading; episode (b) contains the strategy of reading ahead and a negative monitoring statement. The number of episodes which contained more than one negative monitoring statement was very small - less than 2% - so the above procedure was used infrequently.

Analysis of self regulation was undertaken in three ways: first on the number of comprehension episodes; second on the number of comprehension episodes that contained negative monitoring statements; and third on the number of strategies used with each negative monitoring statement. The mean number of comprehension episodes generated by good and poor learners is shown in Figure 2.16.

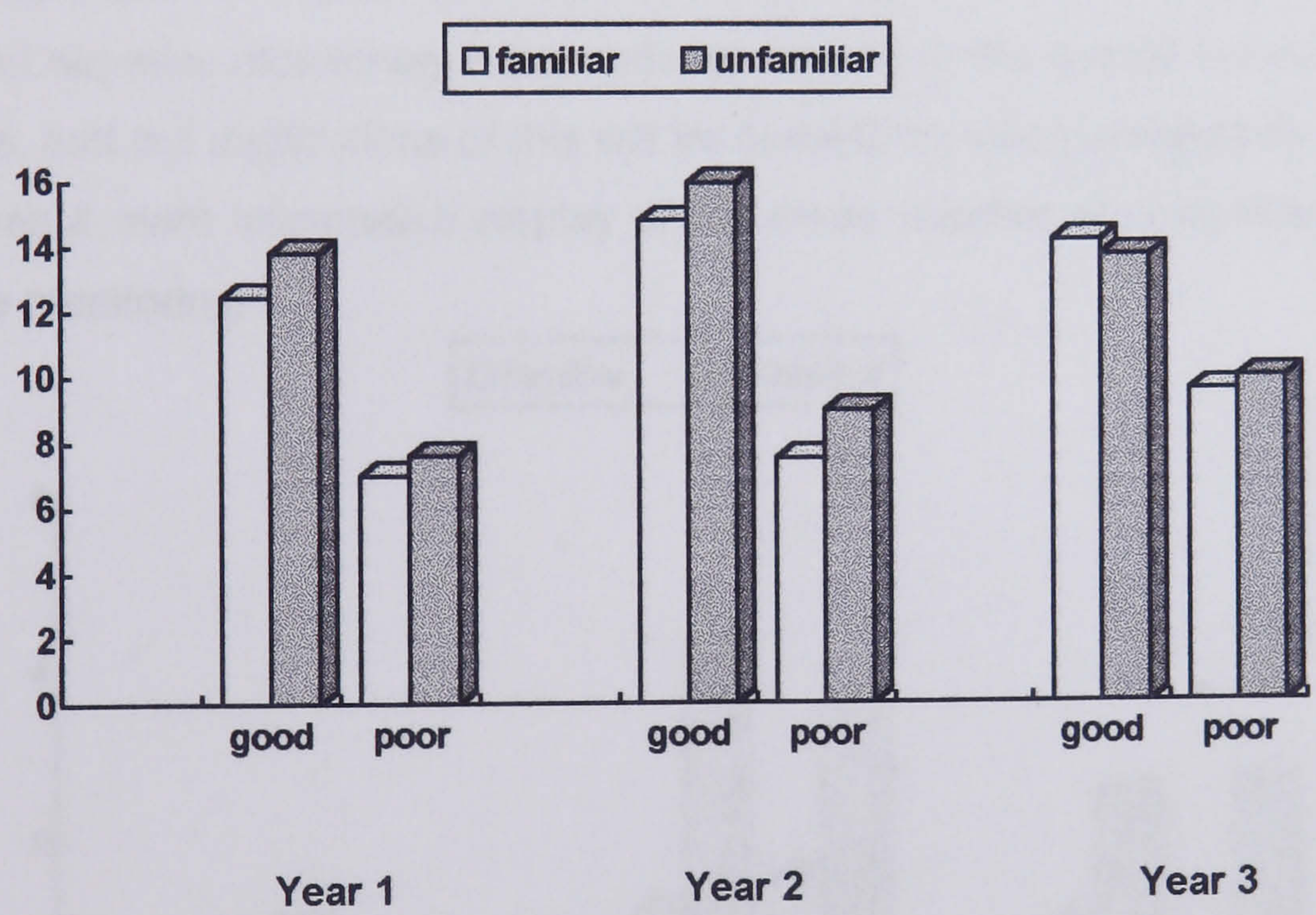
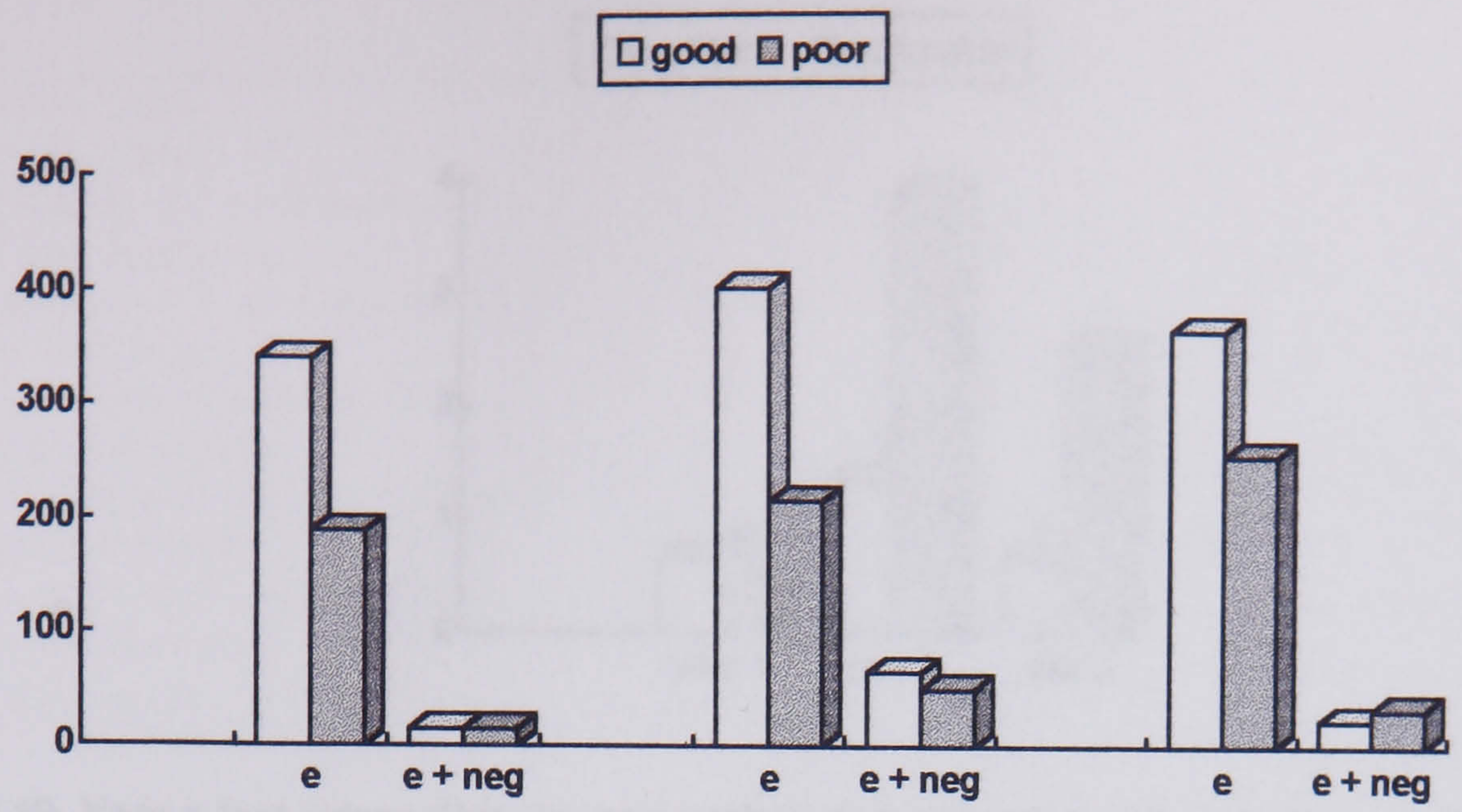


Figure 2.16 Mean number of comprehension episodes of good and poor learners.

Analysis on the data in Figure 2.16 found that good learners (mean 14.1) had more episodes than poor learners (mean 8.45) ($F=7.29$, df 1,24, $p<.02$). Differences in text familiarity just missed significance ($F=3.37$, df 1,24, p.07); more episodes tended to be made with unfamiliar (mean 11.7) than familiar texts (10.9).

Analysis was then carried out on the number of comprehension episodes that also contained negative monitoring. The *total* number of comprehension episodes is compared with the *total* number of comprehension episodes that also contain negative monitoring in Figure 2.17



e comprehension episodes; **e + neg** comprehension episodes that contain negative monitoring.

Figure 2.17 Total number of comprehension episodes (e) and the total number of comprehension episodes which contained a negative monitoring statement (E + neg)

Initial inspection of Figure 2.17 reveals that very few comprehension episodes actually contained negative monitoring statements, compared to the overall number of comprehension episodes, and the implications of this will be considered when interpreting the findings. Figure 2.18 gives a more informative display of the mean number of comprehension episodes with negative monitoring.

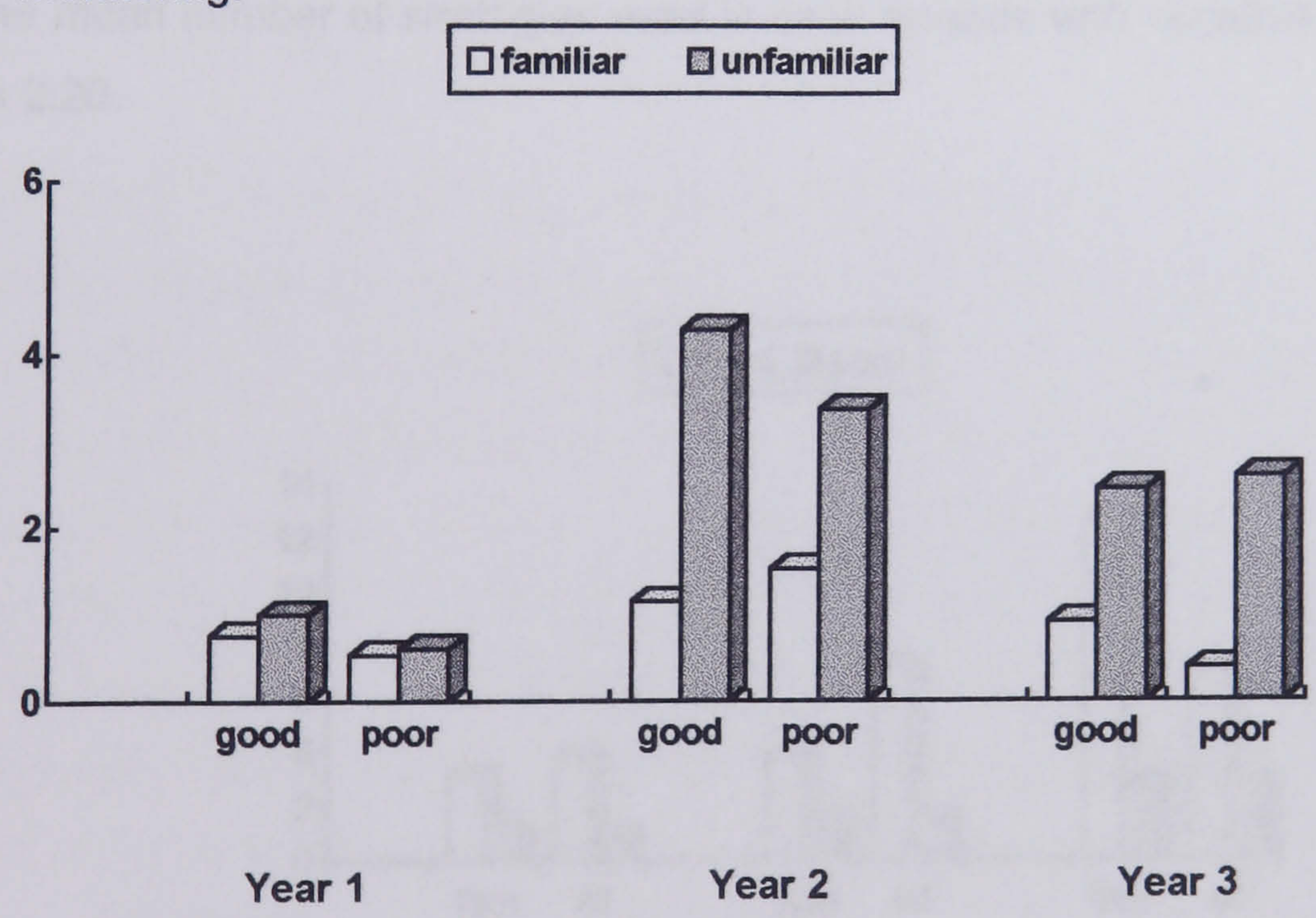


Figure 2.18 Mean number of comprehension episodes with negative monitoring statements.

Analysis on the data in Figure 2.18 found a main effect of year (F=9.87, df 2,48, p<.001); a main effect of text (F=10.15, df 1,24, p<.01); with these 2 factors interacting (F=7.10, df 2,48, p<.01). More episodes with negative monitoring were made in year 2 (mean 2.5) than year 3 (mean 1.5) or year 1 (mean 0.7); and more were made with unfamiliar (mean 2.3) than familiar (mean 0.8) texts. The year x text interaction is shown in Figure 2.19

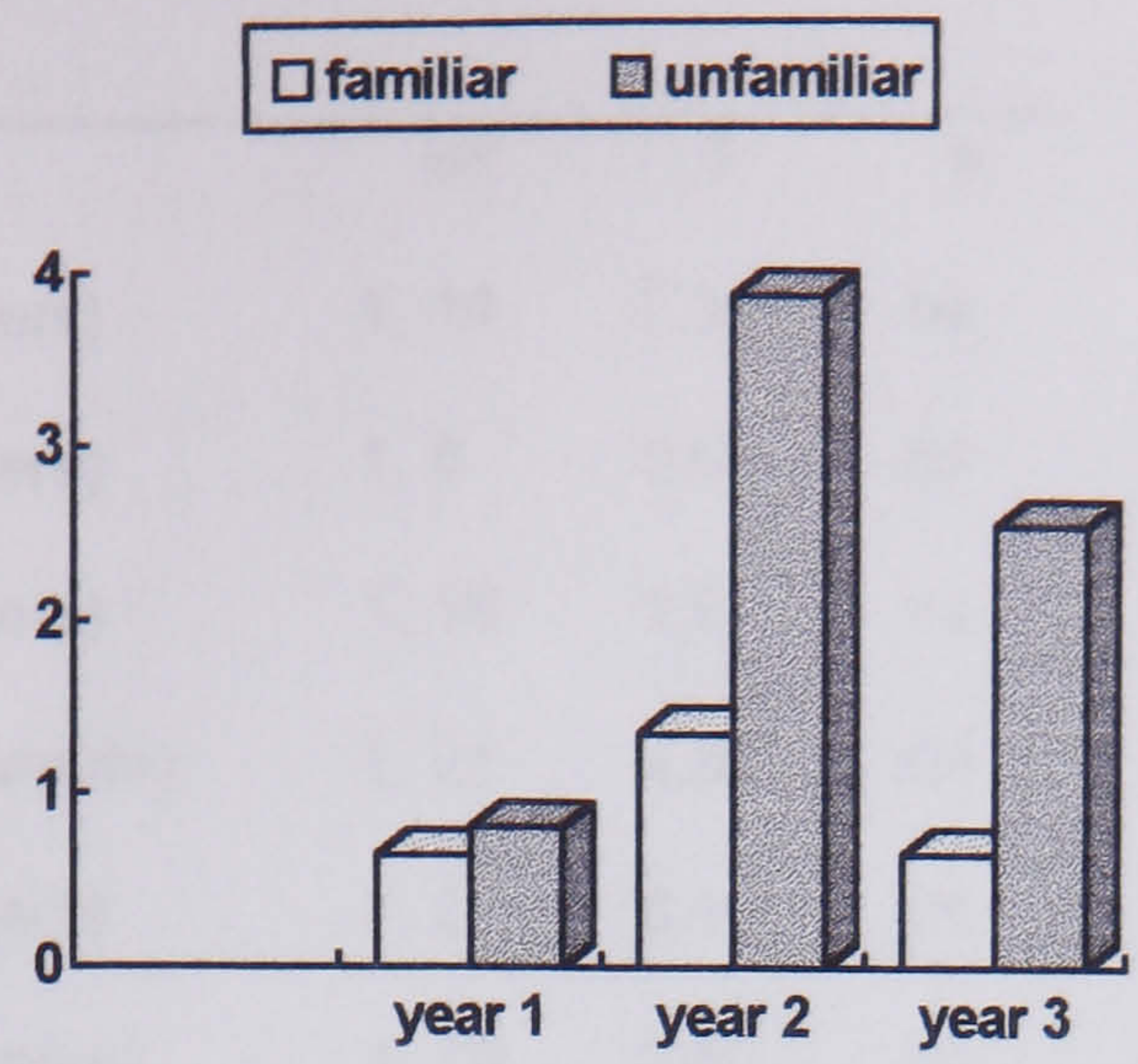
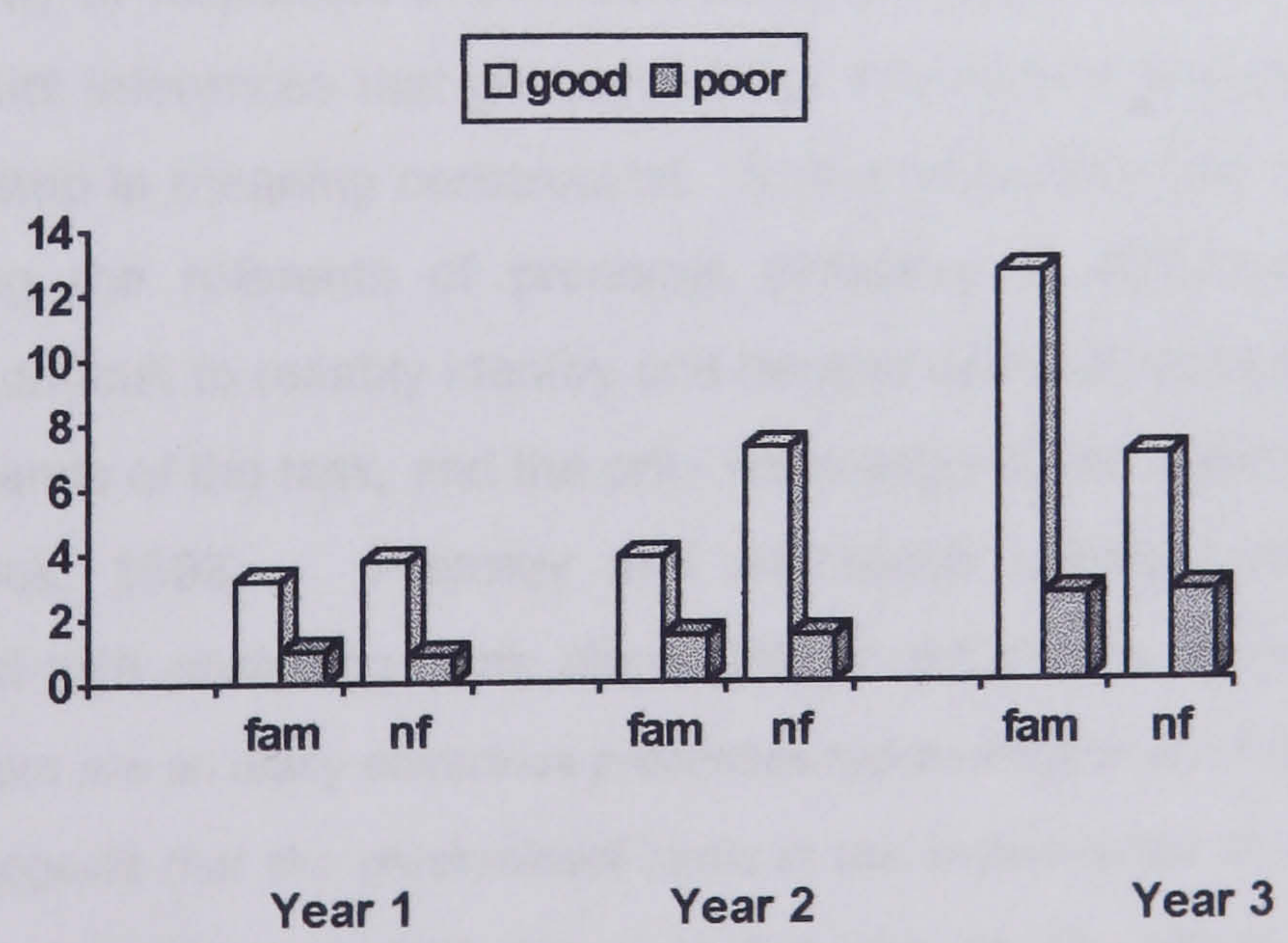


Figure 2.19 Year x text interaction for comprehension episodes with negative monitoring.

Figure 2.19 shows the interaction arises because of the greater number of comprehension episodes with negative monitoring with unfamiliar texts in years 2 and 3.

Finally, analysis was carried out on the number of strategies used with negative monitoring. As the measure of self regulation necessitated negative monitoring, students who did not monitor text negatively were excluded from the analysis. To avoid further subject wastage by excluding subjects who did not monitor both familiar and unfamiliar texts, and who did not monitor in each year of study, separate analyses were carried out for each text, and for each year. The mean number of strategies used in each episode with negative monitoring is shown in Figure 2.20.



Code: fam familiar text; **nf** unfamiliar text

Figure 2.20 Mean number of strategies used with negative monitoring.

The outcomes of analyses on the data in the above 3 Figures is shown in Table 2.7 overleaf.

source of variation	df	F	p
year 1 familiar texts			
group (6 good and 6 poor learners)	1, 10	2.39	ns
year 1 unfamiliar texts			
group (4 good and 6 poor learners)	1, 8	3.58	.09
year 2 familiar texts			
group (9 good and 9 poor learners)	1, 16	1.91	ns
year 2 unfamiliar texts			
group (10 good and 13 poor learners)	1, 21	4.87	.04
year 3 familiar texts			
group (4 good and 3 poor learners)	1, 5	8.11	.04
year 3 unfamiliar texts			
group (8 good and 13 poor learners)	1, 19	2.52	ns

Table 2.7 Outcomes of analysis on strategy use before or after negative monitoring.

Analysis revealed good learners used more strategies with negative monitoring than poor learners with the year 2 unfamiliar text (good 3.6, poor 0.7) and the year 3 familiar text (good 6.3, poor 1.3). It should be noted that with some texts, the number of subjects in the analysis, and hence the degrees of freedom, give cause for concern. The main problem was that few subjects actually negatively monitored their understanding while reading. Table 2.7 shows that only 4 good and 6 poor students negatively monitored their understanding of the year 1 unfamiliar text; 6 good and 6 poor learners negatively monitored their understanding of the year 1 familiar texts; and 4 good and 3 poor students negatively monitored their understanding of the year 3 familiar text.

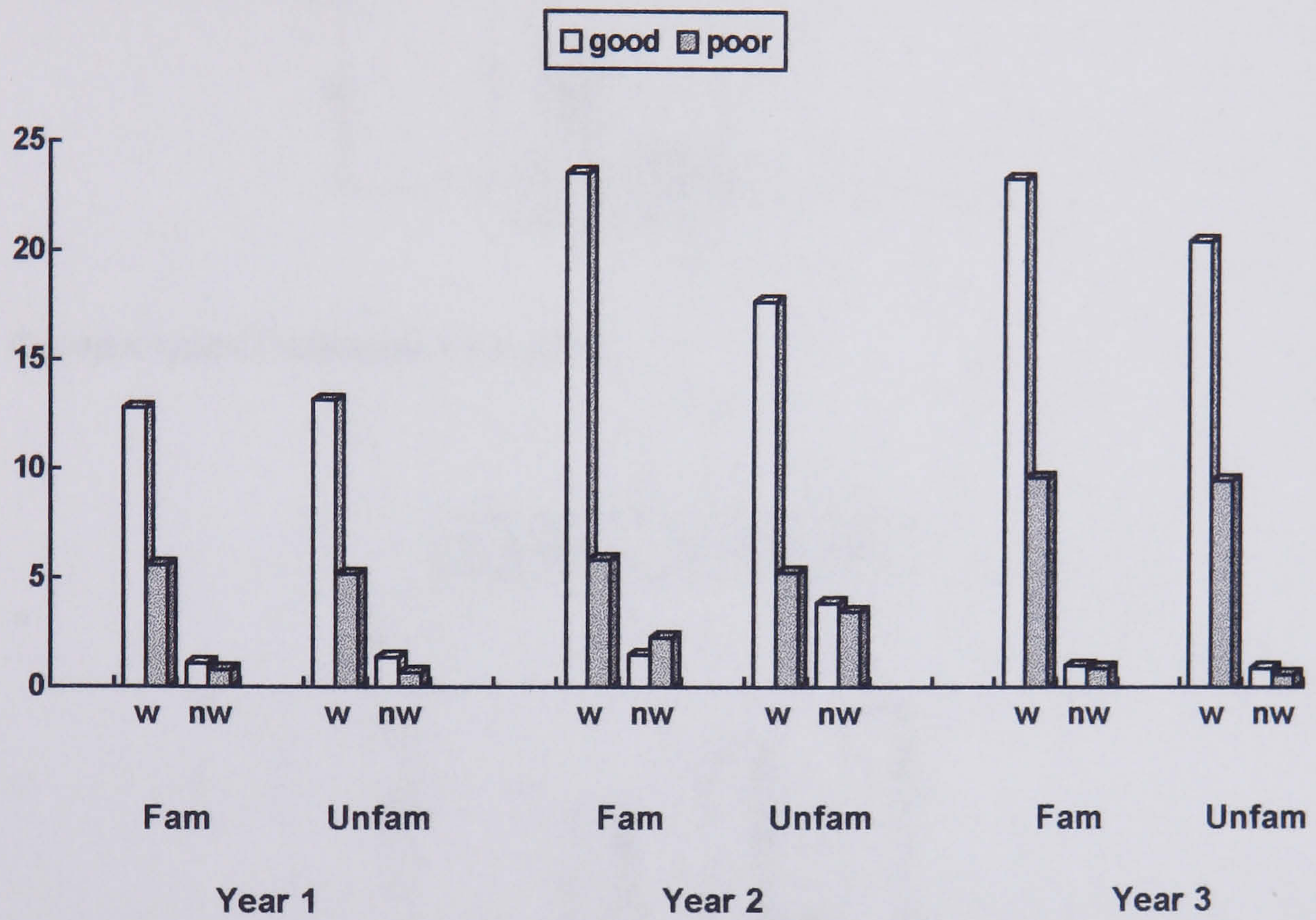
2.12 Inferences Inferences and restatements (i.e. restating the text in your own words) comprised the majority of responses in the think aloud protocols. Based on prior knowledge, readers often construct inferences that go beyond the information presented in the text, and this is an important step in meaning construction. Some inferences can be reliably identified, for example inferring the referents of pronouns (Pressley & Afflerbach, 1995). Other inferences are more difficult to reliably identify and depend upon situational factors such as the type of text, the demands of the task, and the prior knowledge of the reader (Graesser & Kreuz, 1993; van den Broek, 1993). Pressley and Afflerbach (1995) succinctly describe the difficulties associated with analysing think aloud data to determine whether inferences have been made. "*That there are so many conscious processes represented in the think alouds that seem to relate to inference suggests that the predominant tactic in the experimental literature of attempting to determine whether an inference occurred or not is but part of the picture.* (1995, p 94-95). Restatements are defined as restating the text into your own words and also aid meaning construction. Distinguishing restatements from inferences in the present study was a subjective task because it involves determining whether the think alouds contain only textual information or reflect some degree of the reader's prior knowledge. This is a difficult task to accomplish with acceptable reliability. Therefore, restatements and inferences were not distinguished for the purposes of analysis with the category called "*inferences*". Inferences were categorised as warranted (i.e. plausible given the text content is true) and unwarranted (i.e. not plausible given the text content is true). Examples are shown below.

Text Propositional representations are likely to resemble surface form rather than direct phonetic transcriptions of an utterance, since it is almost impossible for native speakers to suppress the process of identifying words and recovering some syntactic relations.

Warranted Inference *So .. the surface form ... would be the grammatical style in which it's written ...*

Unwarranted Inference *I think that's saying .. that there's some link to actual phonetic sound.*

The mean number of warranted and unwarranted inferences for good and poor learners is shown in Figure 2.21.



Code: W warranted inferences; **nw** unwarranted inferences

Figure 2.21 Warranted (w) and unwarranted (nw) inferences for good and poor learners.

Analysis of variance was carried out on the data in Figure 2.21, and the outcomes of the analyses are shown in Table 2.8. Analysis revealed that good learners (mean 10.2) generated more inferences than poor learners (mean 4.2); that the generation of inferences increased with the year of study (mean year 1 = 5.1, year 2 = 8.0, year 3 = 8.4); and that more warranted (mean 12.8) than unwarranted (mean 1.6) inferences were made.

Source of variation	df	F	p
group	1,24	6.64	.02
year	2,48	8.09	.001
type	1,24	35.57	.000
group x type	1,24	9.48	.005
year x type	2,48	9.38	.000
text x type	1,24	5.41	.029
group x year x type	2,48	3.29	.046
year x text x type	2,48	3.12	.05

Table 2.8 Outcomes of analyses on inferences.

Table 2.8 shows that there were three 2-way interactions: a group x type of inferences interaction is shown in Figure 2.22; a year by type of inference is shown in Figure 2.23; and a text x type of inference is shown in Figure 2.24.

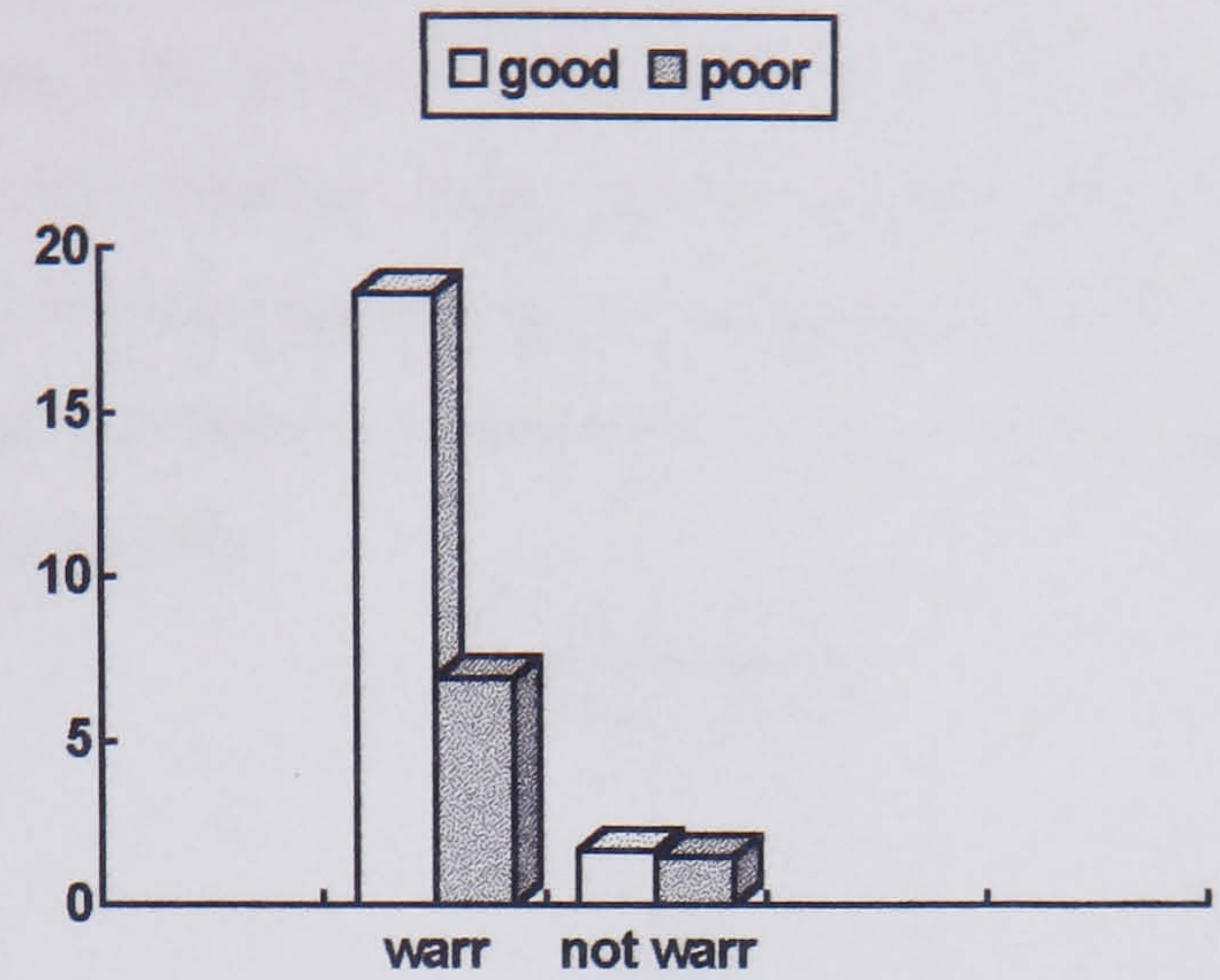


Fig 2.22 Group x type of inference interaction.

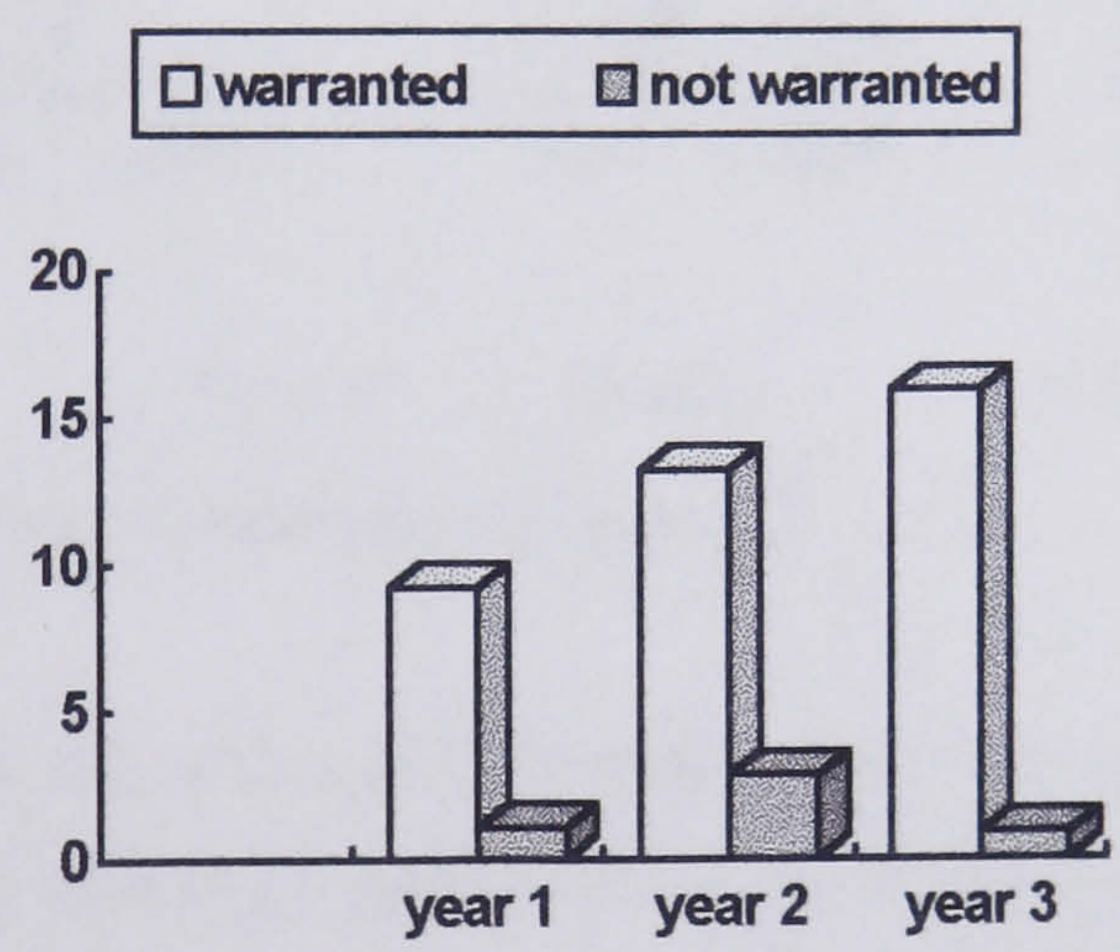


Fig 2.23 Year x type of inference interaction

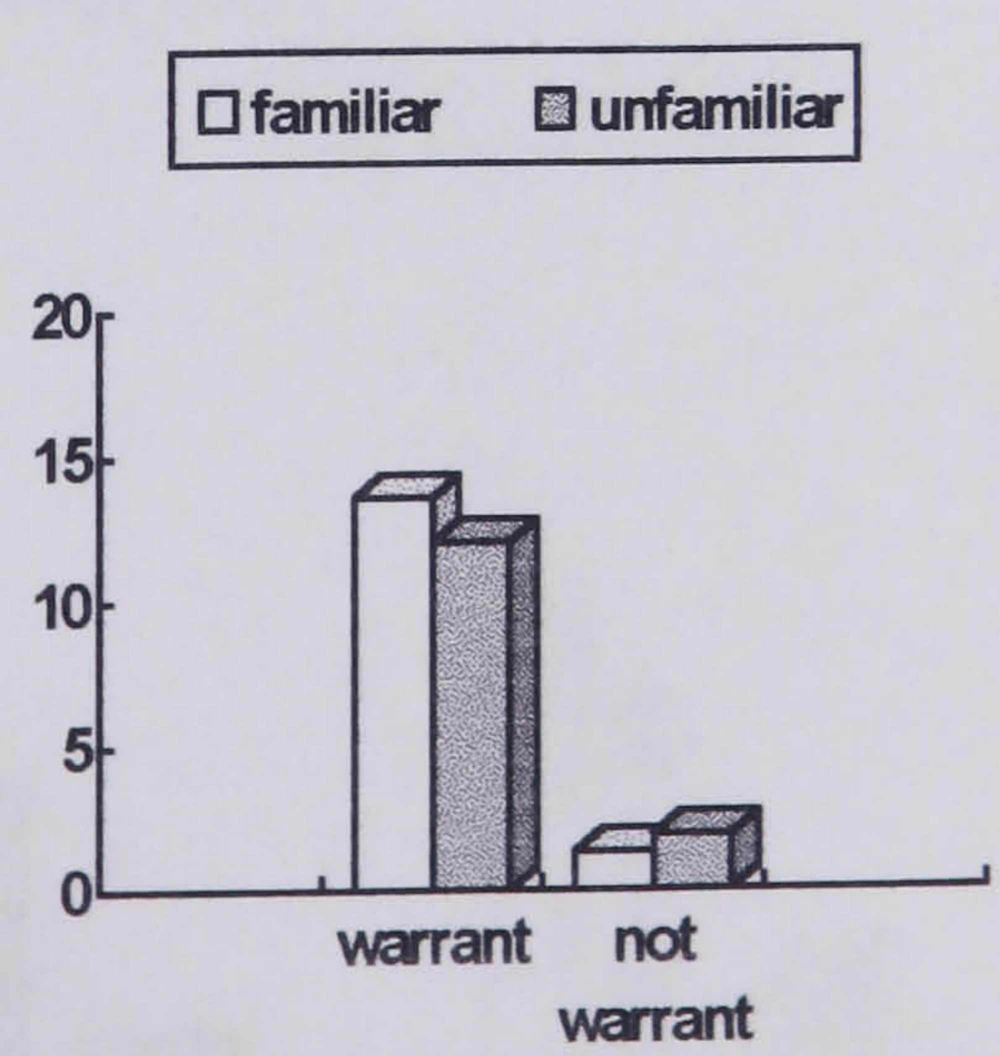


Fig 2.24 Text x type of inference interaction for good and poor learners.

Figure 2.22 shows the group x type of inference interaction arises because good learners, compared to poor learners have many more warranted inferences but only slightly more unwarranted inferences. Figure 2.23 shows the year x type of inference interaction arises because warranted inferences increase from year 1 to year 3 while unwarranted inferences are greatest in year 2. Figure 2.24 shows the text x type of inference arises because warranted inferences are greater with familiar texts while unwarranted inferences are greater with unfamiliar texts. These two way interactions culminate in two 3-way interactions: a group x year x type of inference interaction is shown in Figure 2.25 while a year x text x type of inference is shown in Figure 2.26.

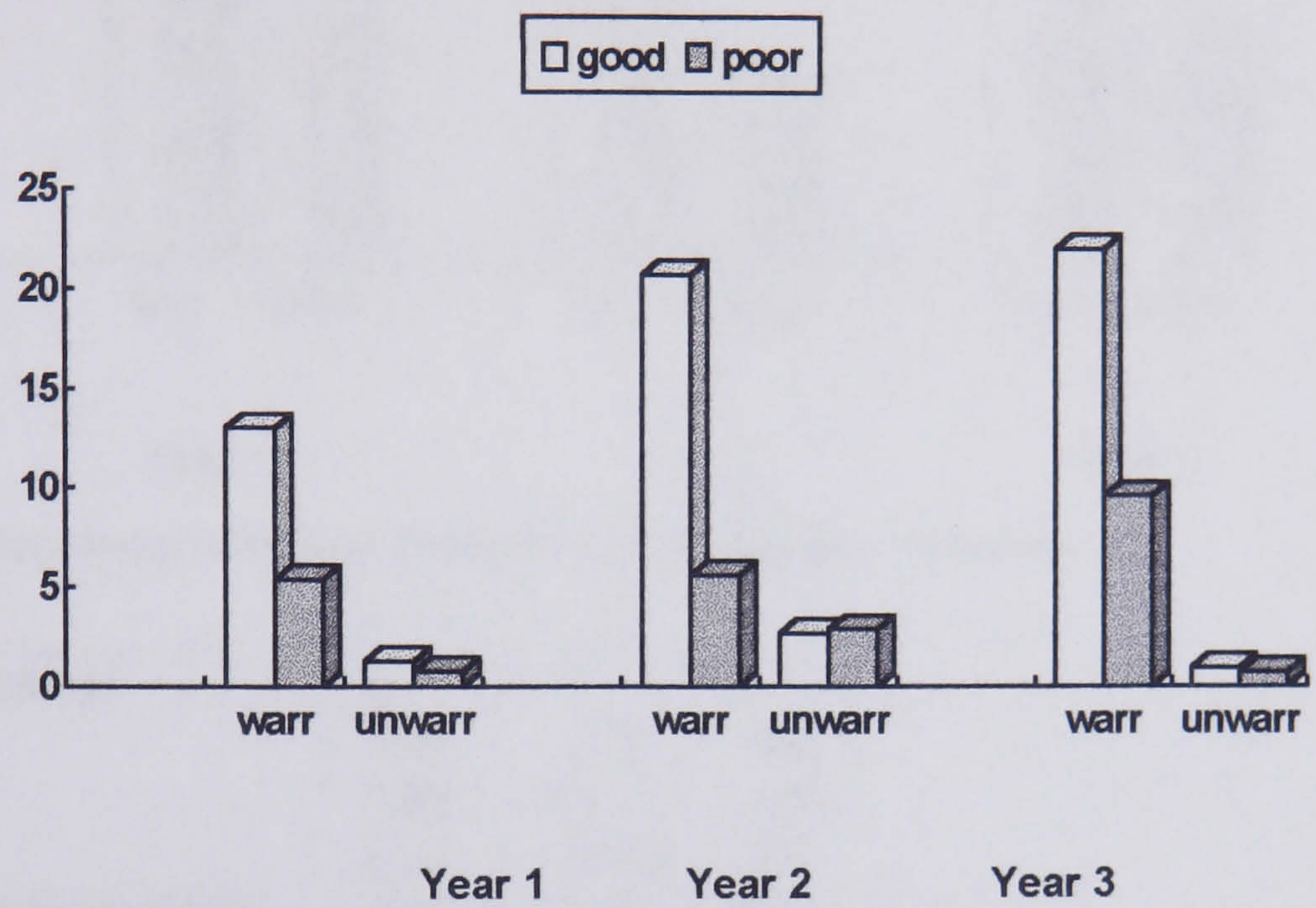


Figure 2.25 Group x year x type of inference interaction.

Figure 2.25 shows this interaction arises because poor learners had slightly more unwarranted inferences than good learners with the year 2 texts. In contrast, good learners generated more warranted and unwarranted inferences than poor learners in all other conditions. Figure 2.26 shows the interaction arises because warranted inferences increase from year 1 to year 3 with both familiar and unfamiliar texts. In contrast, unwarranted inferences are greatest with the familiar and unfamiliar second year texts.

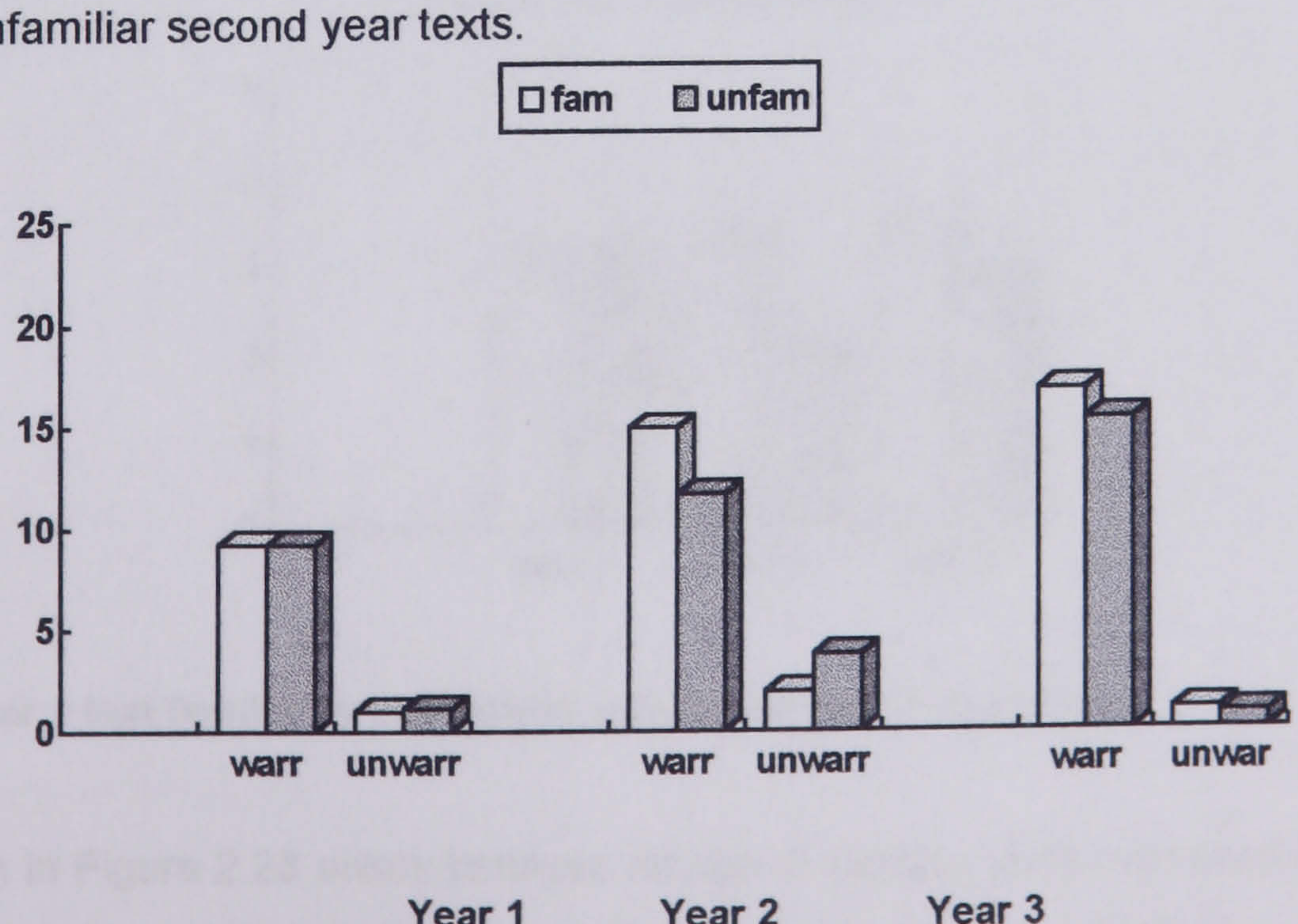


Figure 2.26 Year x text x type of inference interaction: good and poor learners.

2.13 Ratings of comprehension Measures of the students' comprehension were obtained after students had read each text. A 5 point Likert type scale was used ranging from **1** (very poor comprehension) to **5** (very good comprehension). The mean comprehension ratings are shown in Figure 2.27 and outcomes of analysis on this data are shown in Table 2.9.

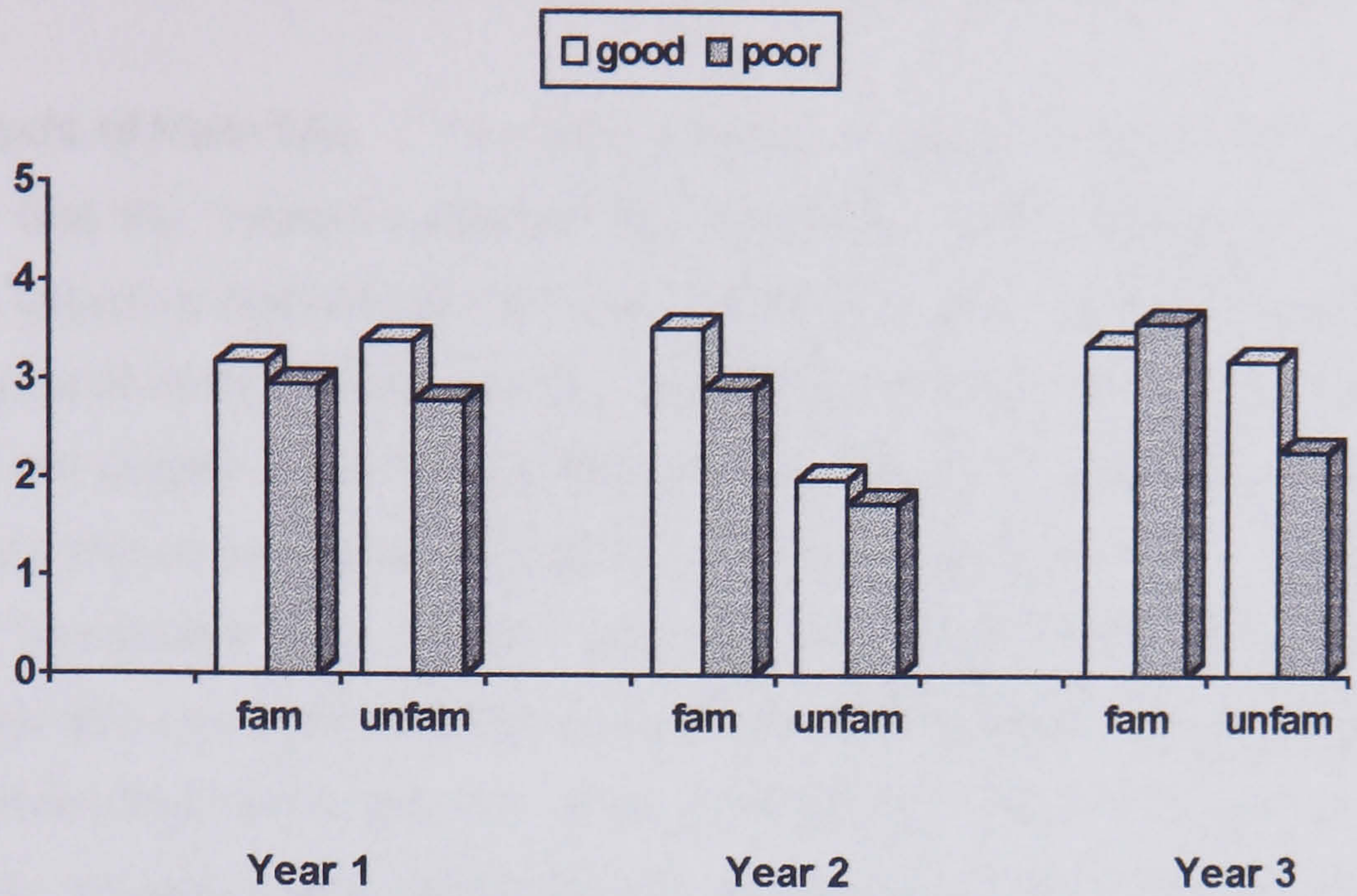


Figure 2.27 Mean comprehension ratings of good and poor learners.

Source of variation	df	F	p
year	2,42	7.08	.002
text	1,21	31.2	.000
year x text	2,42	10.60	.000
good vs. poor x year x text	2,42	3.45	.04

Table 2.9 Outcomes of analysis on comprehension ratings.

Analysis of comprehension ratings revealed main effects of year and text, with these 2 factors interacting. Ratings were highest in year 3 (mean 3.1) than year 1 (mean 3.0) or year 2 (mean 2.55) and ratings were higher for familiar (mean 3.2) than unfamiliar (mean 2.5) texts. The 2-way year x text interaction is shown in Figure 2.28.

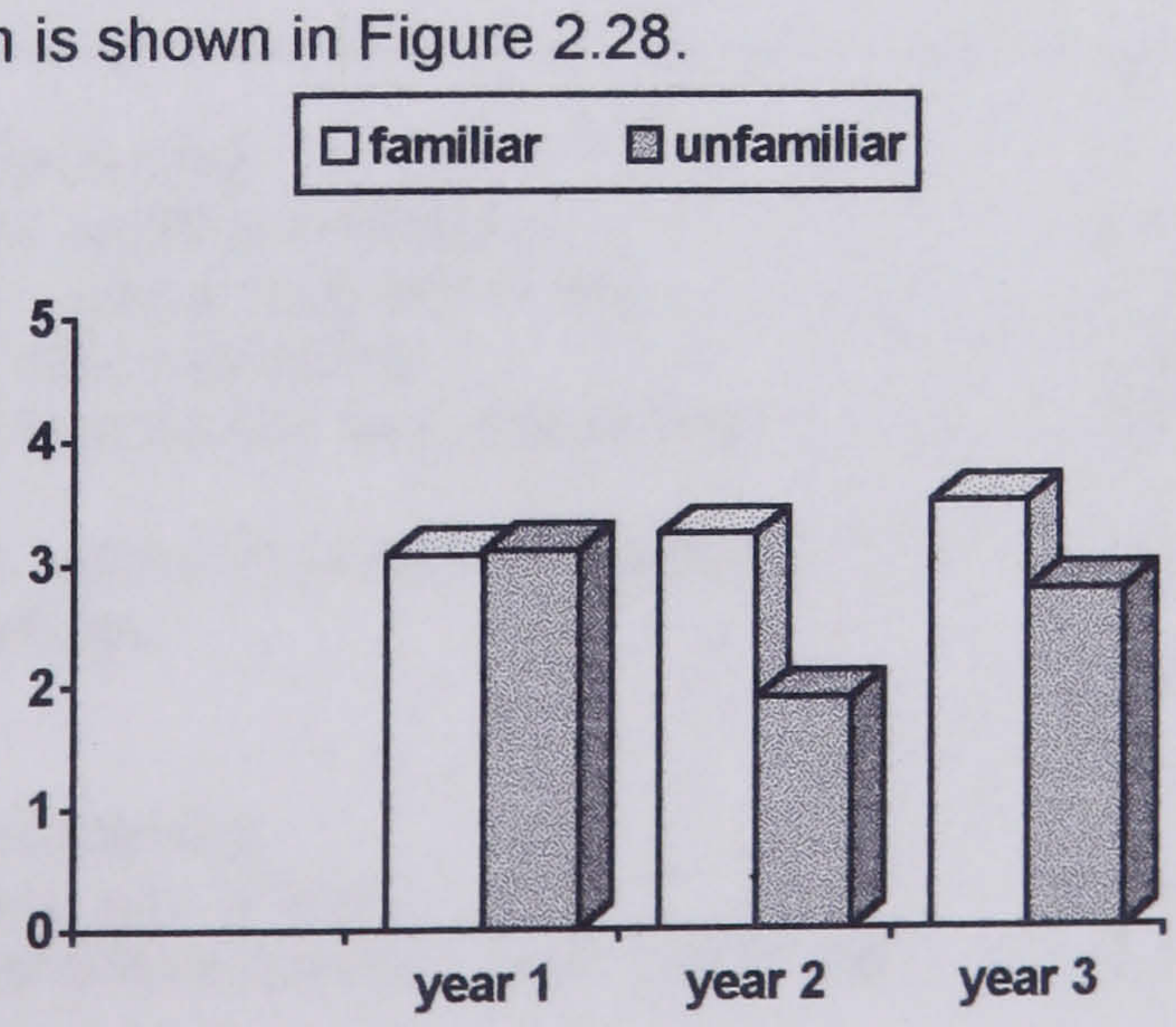


Figure 2.28 Year x text familiarity interaction with comprehension ratings.

The interaction in Figure 2.28 arises because ratings of familiar texts increased from year 1 to year 3 while ratings for unfamiliar texts were much lower in year 2. Table 2.9 shows a 3-way good vs. poor x year x text interaction was found, which can be seen in Figure 2.27. Both groups rated the unfamiliar texts in the same order: year 1 > year 3 > year 2. However no similar pattern was found with familiar texts; the order for good learners was year 2 > year 3 > year 1 while for poor learners the order was year 3 > years 1 and 2.

2.14 Effects of Materials To recap briefly, analysis was carried out to rule out the possibility that the materials affected the outcomes. The procedure involved each student taking the cognitive science course reading a familiar and unfamiliar text in their first, second and third year of study. The selection of familiar and unfamiliar texts was carried out with the advice of the cognitive psychology lecturer who taught the students and she recommended which topics should be familiar and unfamiliar in each year of study. To test for effects of the materials, *two familiar texts* and *two unfamiliar texts* were chosen for each year of the study; one familiar and one unfamiliar text comprised the "version 1" texts while the other familiar and unfamiliar text comprised the "version 2" texts. Any difference in reading behaviour between the version 1 and version 2 texts reflect differences due solely to the materials. All good and poor learners in this study took cognitive psychology in their first year at university, therefore all students were given either the "version 1" or "version 2" familiar and unfamiliar texts. In the second year, 2 good and 3 poor learners did not take cognitive psychology, therefore "version 1" or "version 2" familiar and unfamiliar second-year texts were given to the remaining 11 good and 10 poor students. The third year cognitive psychology course was optional rather than a compulsory part of the degree, and 5 good and 7 poor students elected to study this course. "Version 1" or "version 2" familiar and unfamiliar third year texts were therefore given to these students. Students were randomly given the "version 1" or "version 2" texts and the order of presentation of familiar and unfamiliar texts was counterbalanced. The outcomes of the analysis with the factor of text version can be seen in Table 2.10.

Source of variation	**df**	**F**	**p**
Year 1: comprehension monitoring			
2-way text version x neutral, positive or negative	2,44	7.19	.002
3-way text version x good vs. poor x neut, pos or neg	2,44	3.43	.04
3-way text version x text x neut, pos or neg	2,44	4.49	.02
3-way text version x general or specific x neut, pos or neg	2,44	4.87	.02
Year 1: use of strategies			
4-way text version x good vs. poor x text x type of strategy	5,110	3.60	.005
Year 1: comprehension ratings			
text version	1,19	4.35	.05
Year 2: comprehension monitoring			
3-way text version x text x neut, pos or neg	2,34	5.01	.01
4-way text version x text x general or specific x neut, pos or neg	2,34	5.17	.01
Year 2: use of strategies			
3-way text version x text x type of strategy	5,85	2.91	.01
3-way text version x good vs. poor x type of strategy	5,85	2.58	.03
Year 3: comprehension ratings			
text version	1,8	5.06	.05

Table 2.10 Outcomes of analysis with factor of text version.

Table 2.10 shows that text version interacted with measures of comprehension monitoring, strategy use and comprehension ratings in year 1; with comprehension monitoring and strategy use in year 2; and with comprehension ratings in year 3. **In year 1**, with comprehension monitoring, one 2-way and three 3-way interactions were found: the 2-way text version x type of monitoring (neutral, positive, or negative) interaction is shown in Figure 2.29.

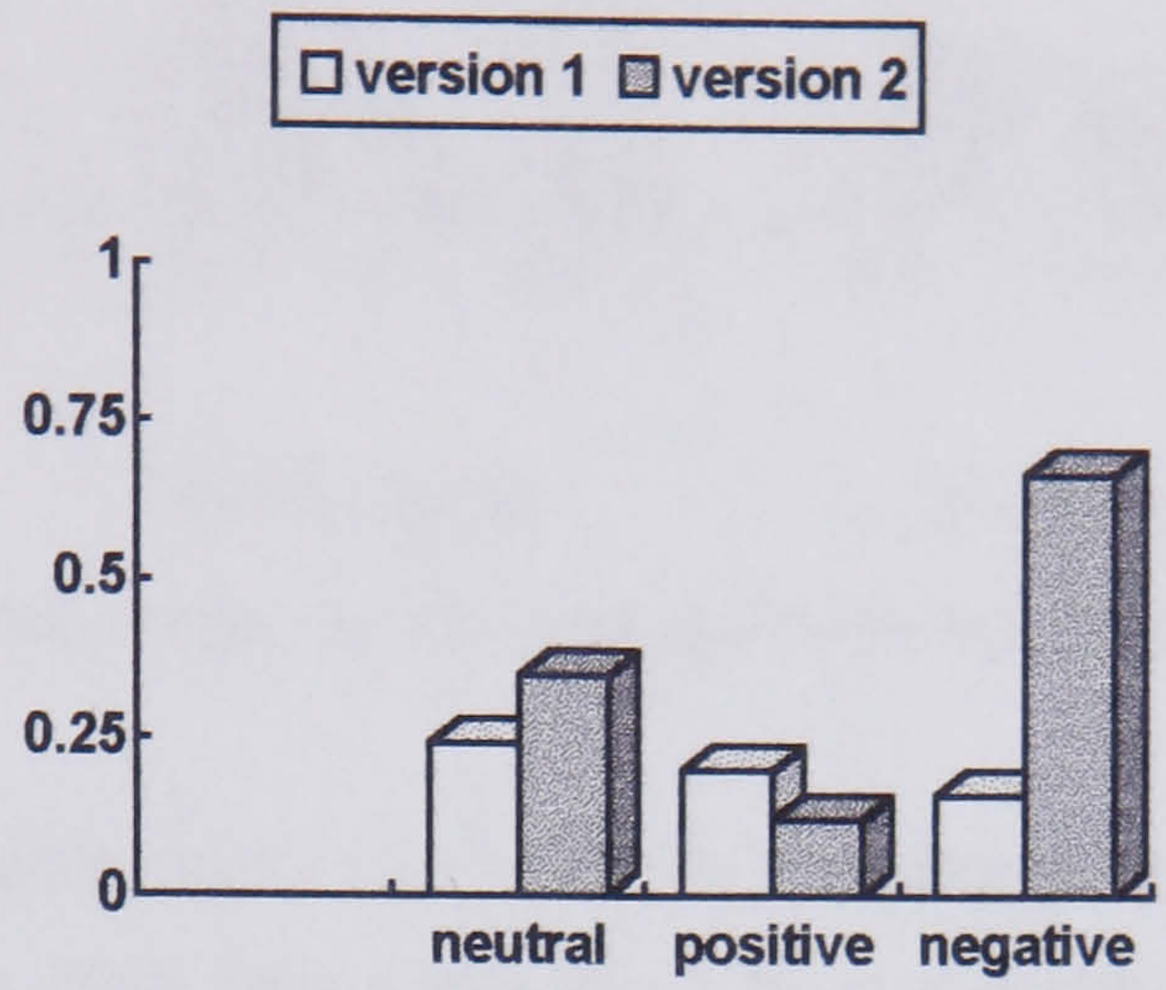


Figure 2.29 Text version x type (positive, negative or neutral) of monitoring interaction: Year 1

Figure 2.29 shows this interaction arises because negative and neutral monitoring were more frequent with the version 2 texts while positive monitoring was slightly greater with the version 1 texts. The 3-way text version x good vs. poor x neutral, positive or negative monitoring is shown in Figure 2.30.

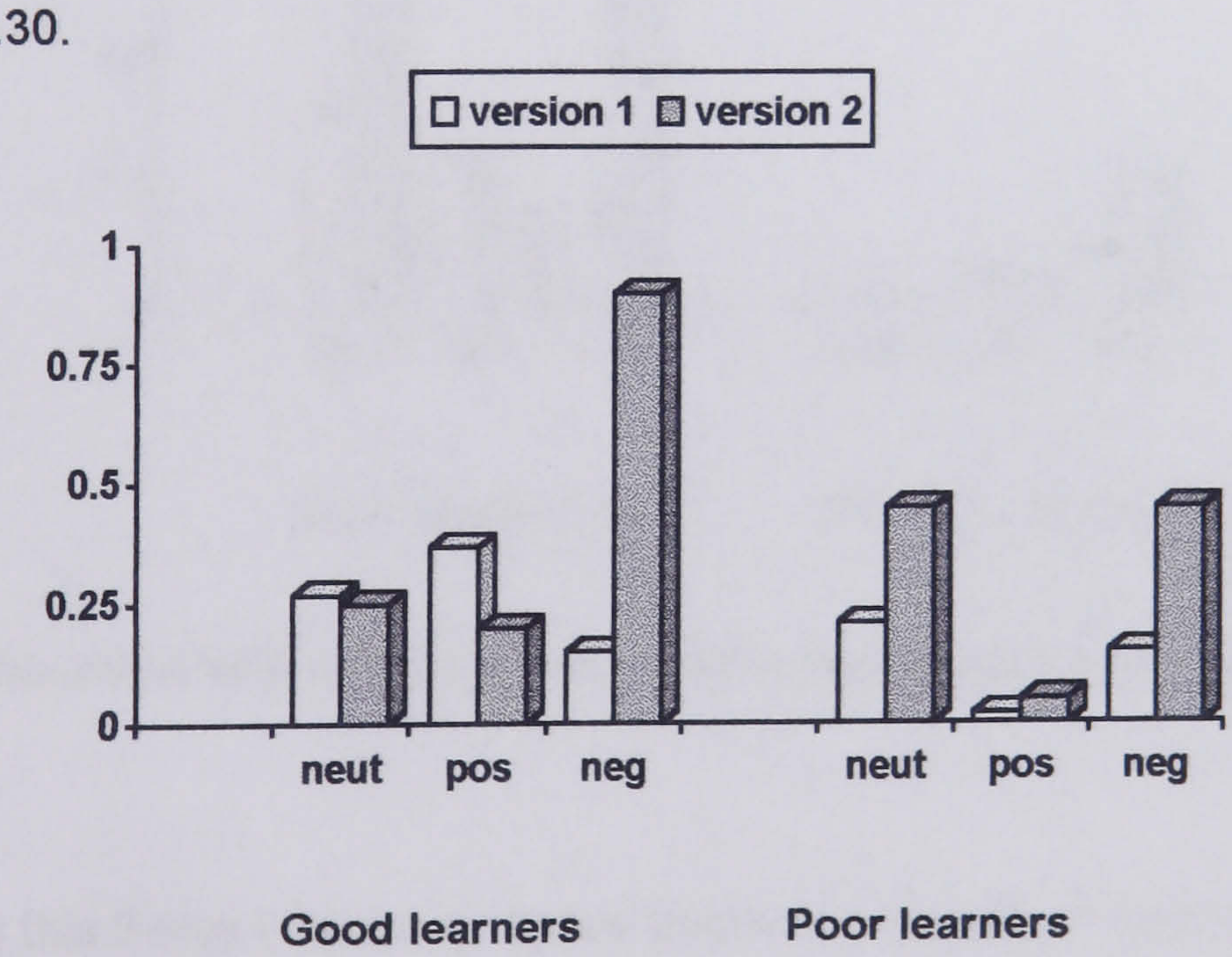


Figure 2.30 Text version x good vs. poor x neutral, positive or negative monitoring interaction: Year 1

Figure 2.30 shows this interaction arises from the more frequent negative monitoring by good learners with the version 2 texts. The 3-way text version x text x type of monitoring interaction is shown in Figure 2.31.

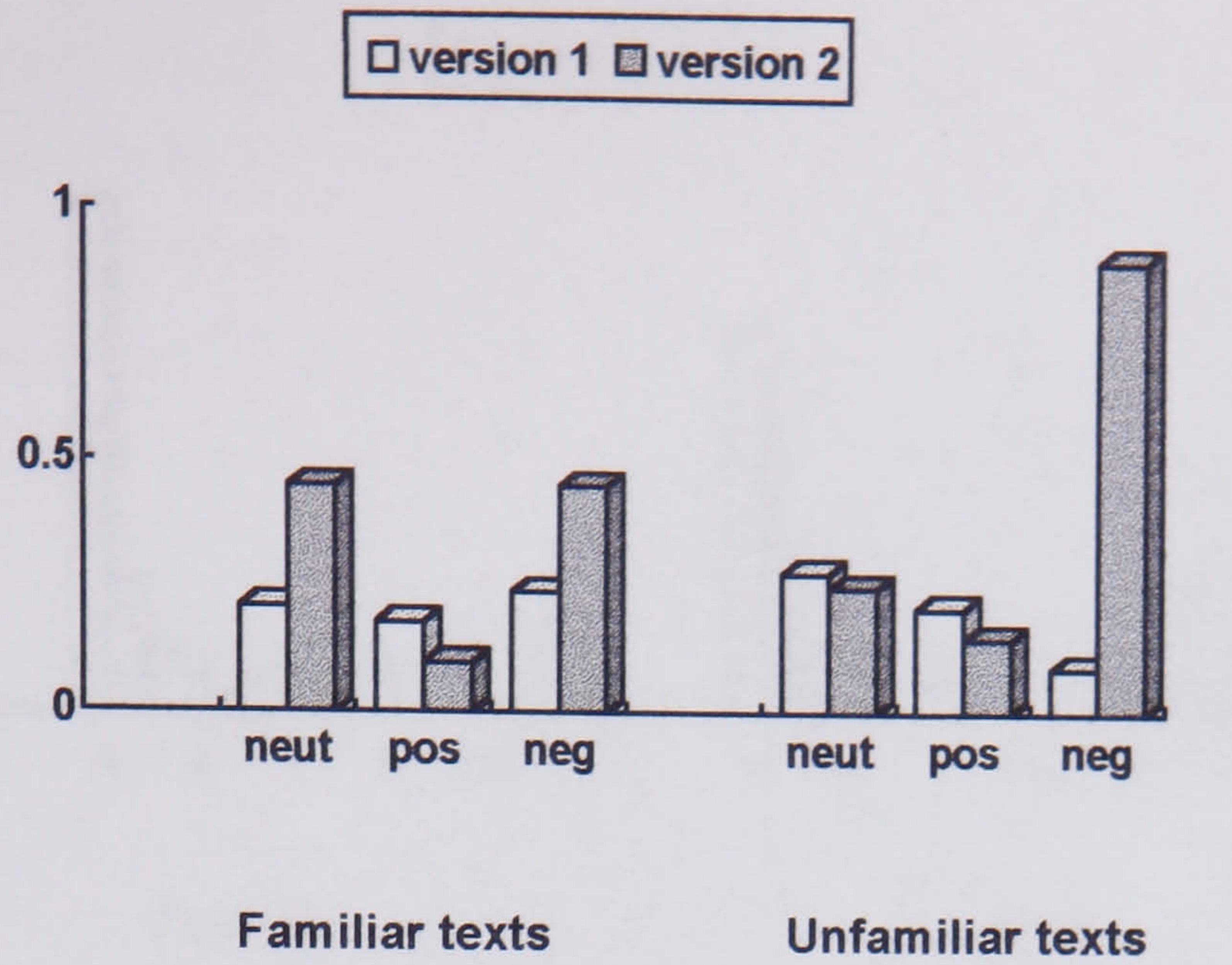


Figure 2.31 Text version x text x type (positive, negative or neutral) of monitoring: Year 1

Figure 2.31 shows the 3-way interaction arises from the more frequent negative monitoring with the version 2 unfamiliar text. The final interaction with comprehension monitoring is the 3-way text version x general or specific monitoring x type of monitoring and is shown in Figure 2.32.

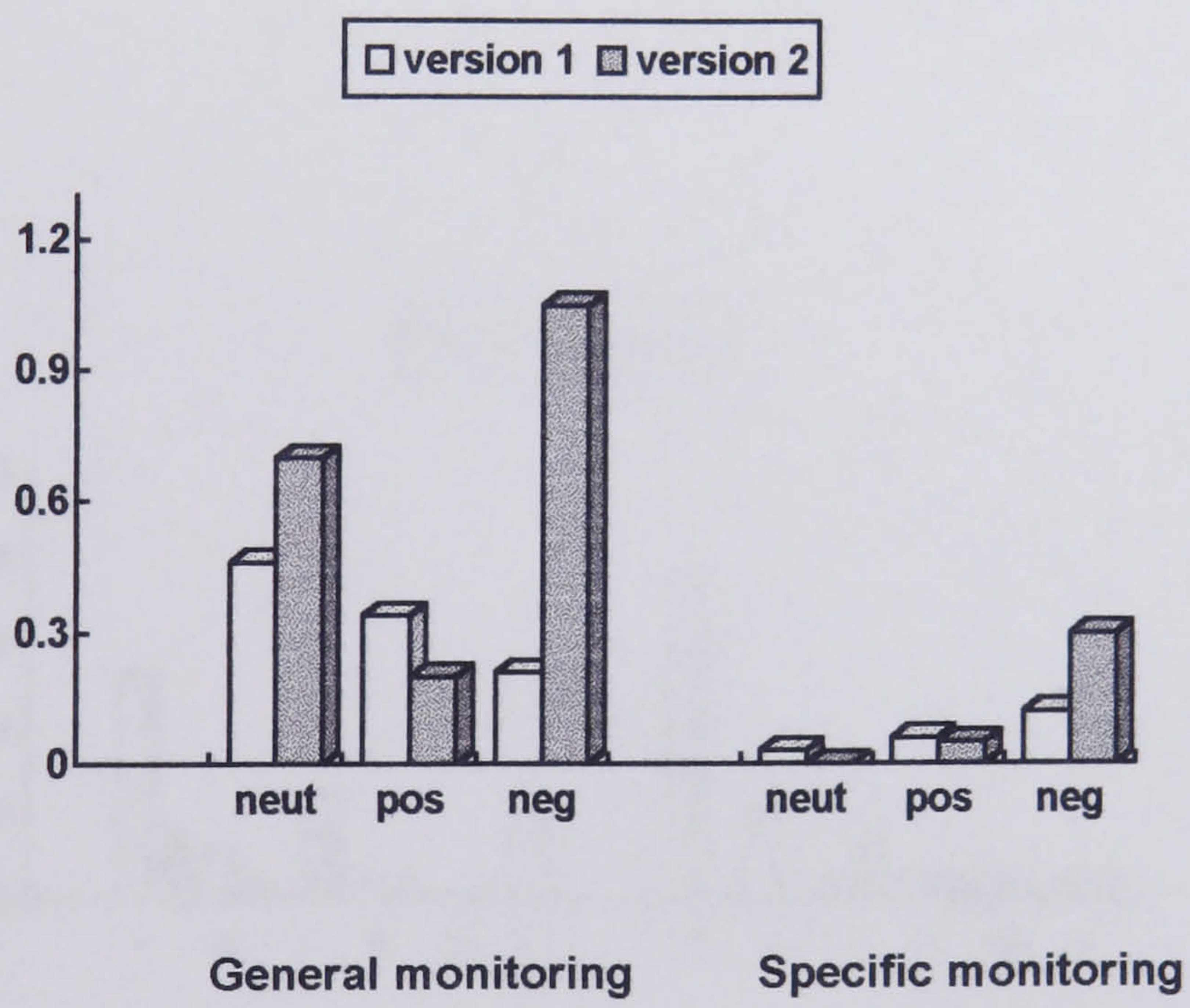
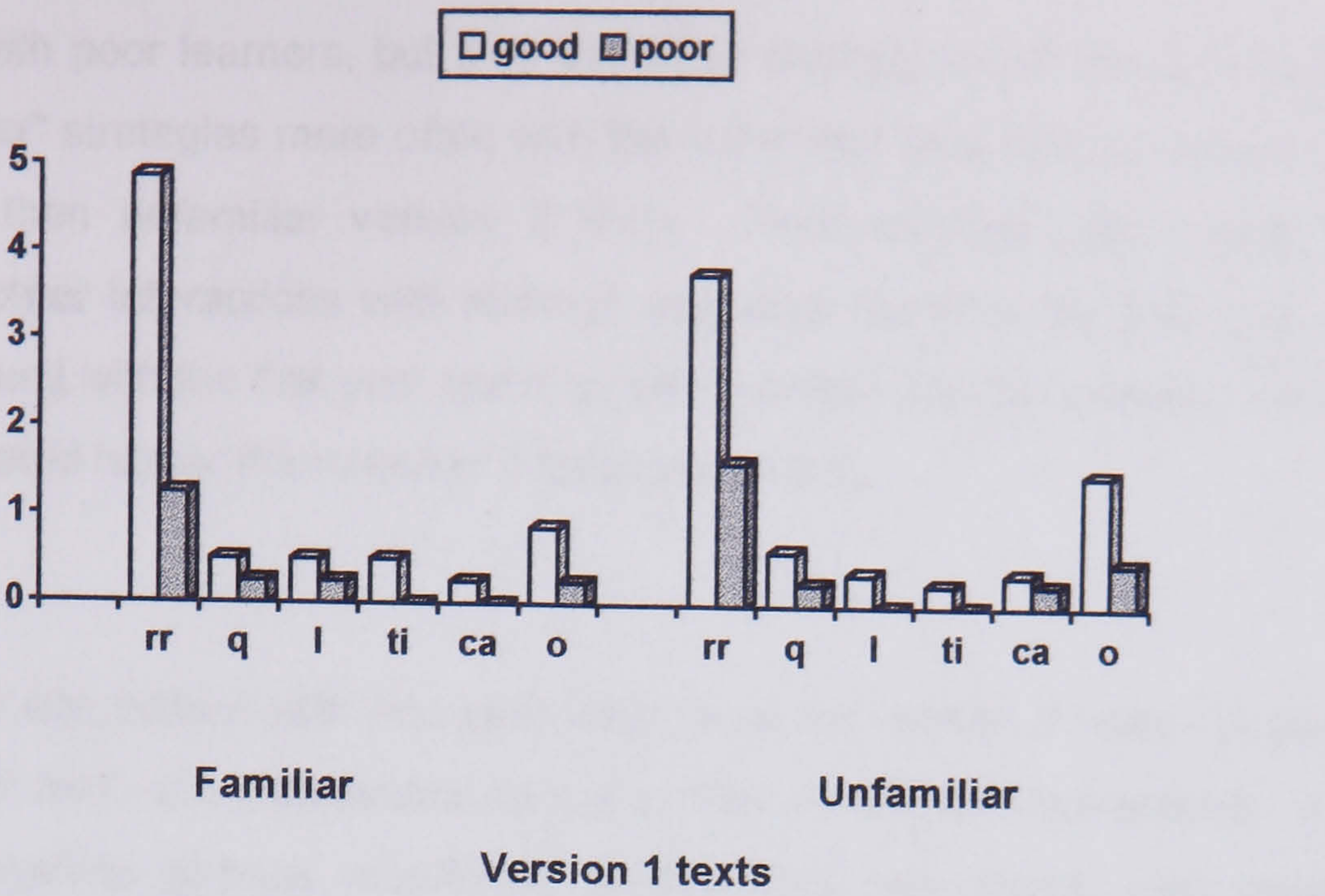


Figure 2.32 Text version x general/specific monitoring x positive/negative neutral monitoring: Year 1

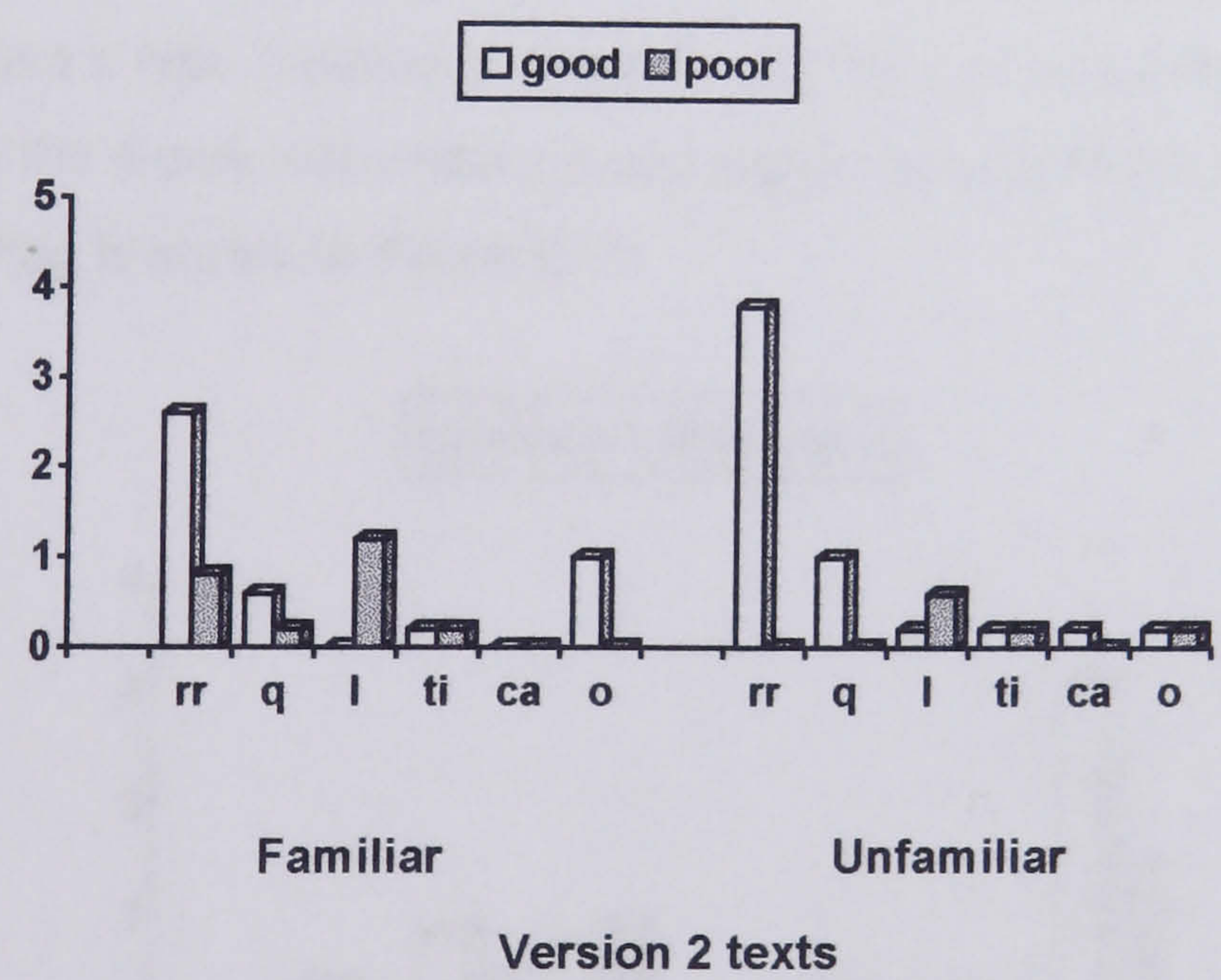
Figure 2.32 shows this 3-way interaction arises because of the more frequent general negative monitoring (and to a lesser extent general neutral monitoring) with the version 2 texts.

With strategy use, a 4-way text version x good vs. poor x text x type of strategy interaction was found and is shown in Figure 2.33 (version 1 texts) and 2.34 (version 2 texts).



Code: **rr** re-read; **q** question; **l** recall prior learning; **ca** challenge author; **o** other

Figure 2.33 Good vs. poor x text x type of strategy interaction with version 1 texts: Year 1



Code: **rr** re-read; **q** question; **l** recall prior learning; **ca** challenge author; **o** other

Figure 2.34 Good vs. poor x text x type of strategy interaction with version 2 texts: Year 1

Figures 2.33 and 2.34 show the interaction arises from differential use of the rereading and other strategies. Good learners used the re-reading strategy more often with the familiar than unfamiliar version 1 text, but with the unfamiliar than familiar with version 2 texts. The reverse trend was found with poor learners, but they used this strategy much less frequently. Good learners used "other" strategies more often with the unfamiliar than familiar version 1 texts but with the familiar than unfamiliar version 2 texts. Poor learners used "other" strategies infrequently. No other interactions with strategy use were found in the first year. One final main effect was found with the first year texts; an effect of text version revealed version 1 texts (mean 3.2) were rated higher than version 2 texts (mean 2.7).

Taken together the interactions with first year texts show the version 2 texts - in particular the version 2 unfamiliar text - are responsible for most of the effects and interactions. A pattern of more frequent negative general monitoring of this text was found, with good learners responsible for much of this negative, general monitoring. Furthermore, when reading the version 2 unfamiliar text good learners reread this text more frequently but used other strategies less frequently. Both groups rated the version 2 texts lower than the version 1 texts suggesting they found these texts the most difficult to understand.

In **year 2**, text version was again found to interact with comprehension monitoring and strategy use. With comprehension monitoring, a 3-way and a 4-way interaction were significant: the 3-way text version x text x type (neutral, positive or negative) of monitoring interaction is shown in Figure 2.35 while the 4-way text version x text x general or specific x type (neutral, positive or negative) monitoring is shown in Figure 2.36.

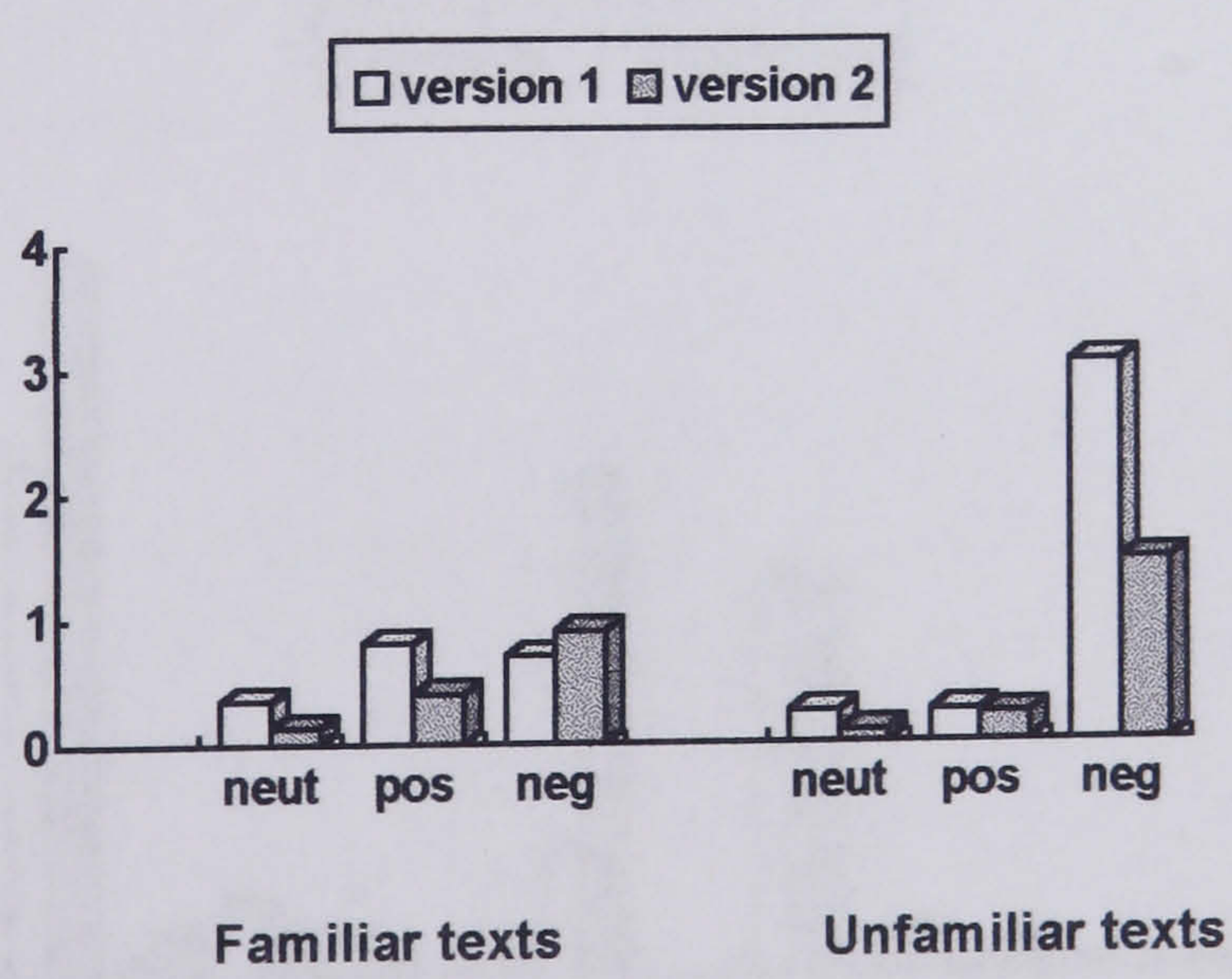


Figure 2.35 Text version x text x type (neutral, positive or negative) of monitoring interaction: Year 2

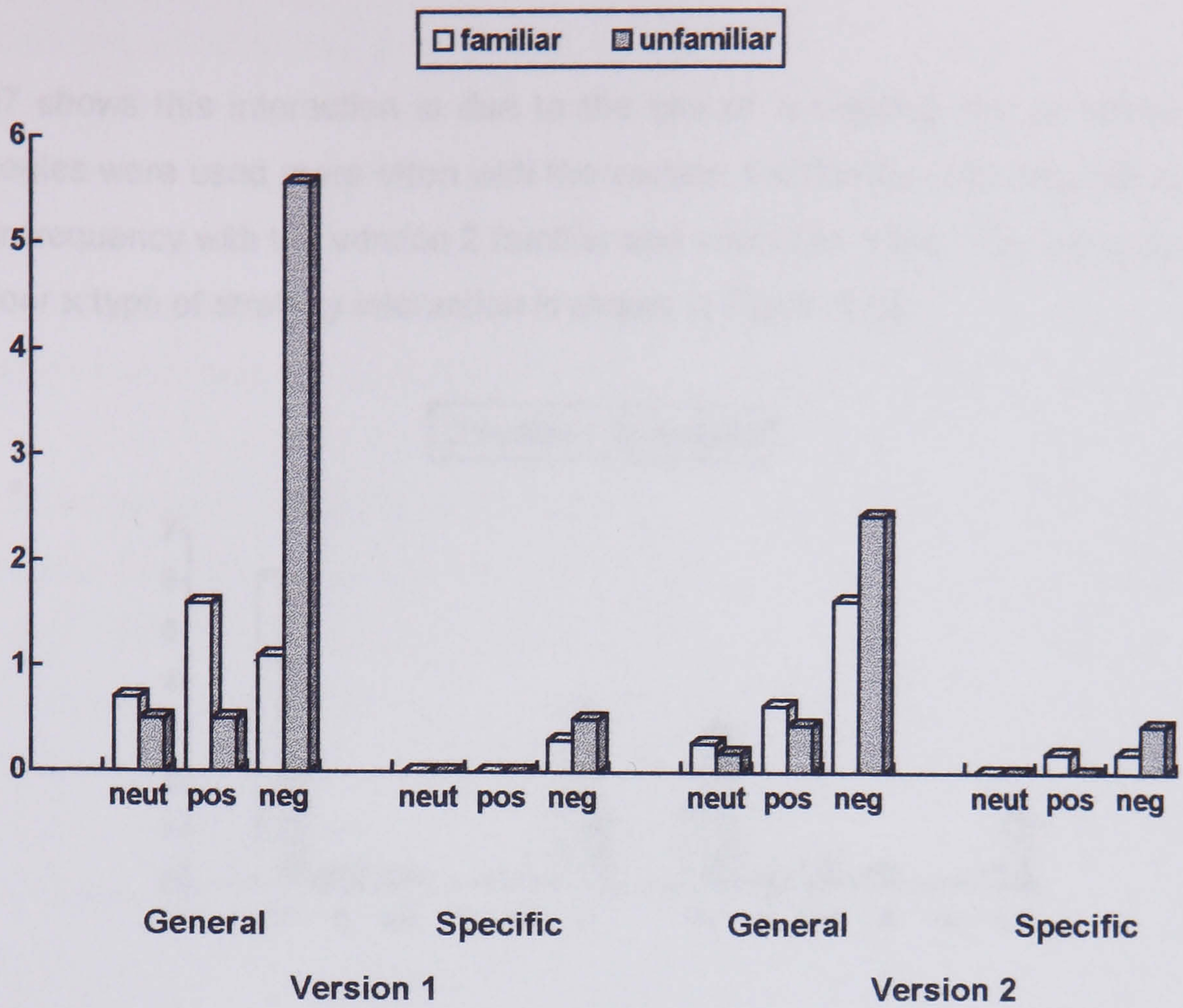


Figure 2.36 Text version x text x general/specific x neutral/positive/negative monitoring: Year 2

The 3-way interaction in Figure 2.35 arises from the more frequent negative monitoring with the unfamiliar version 1 unfamiliar text. The 4-way interaction in Figure 2.36 confines this 3-way interaction to general monitoring as more frequent general, negative monitoring was found with the version 1 unfamiliar text. Table 2.10 shows that two interactions were found with strategy use in the second year. The 3-way text version x text x type of strategy interaction is shown in Figure 2..37.

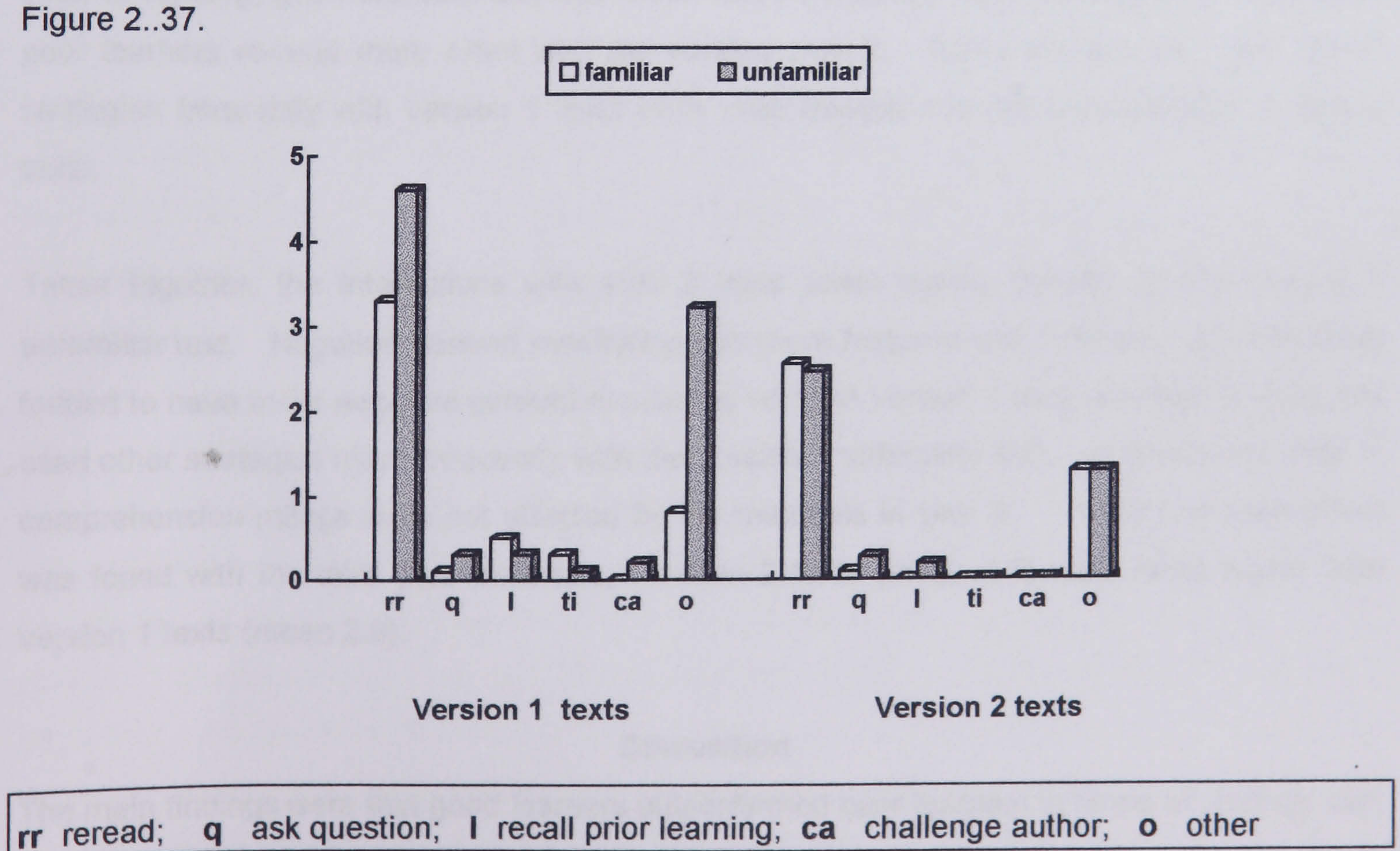
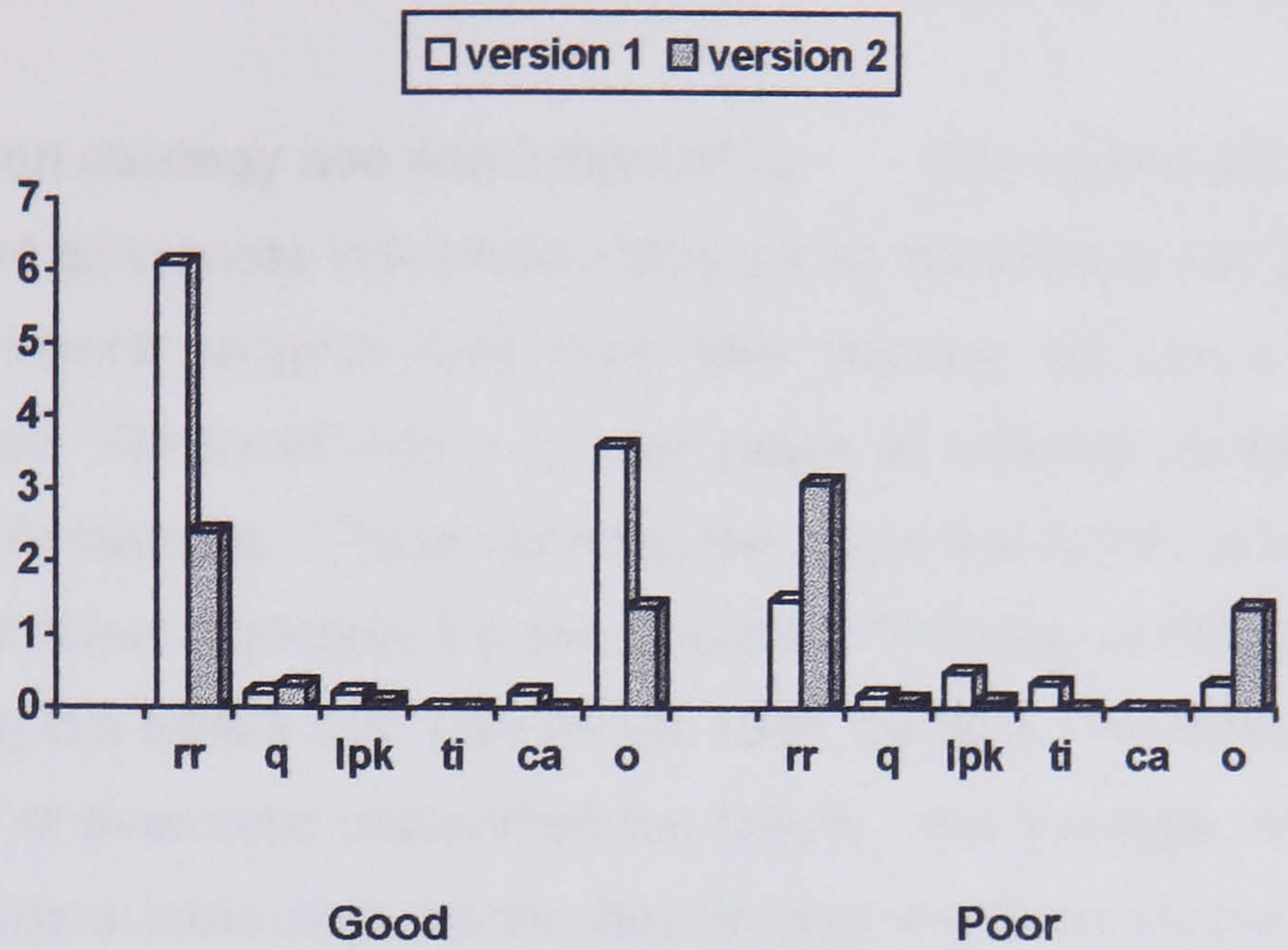


Figure 2.37 Text version x text x type of strategy interaction: Year 2

Figure 2.37 shows this interaction is due to the use of re-reading and of "other" strategies; these strategies were used more often with the version 1 unfamiliar than familiar text but used with similar frequency with the version 2 familiar and unfamiliar texts. The 3-way text version x good vs. poor x type of strategy interaction is shown in Figure 2.38.



rr reread; **q** ask question; **l** recall prior learning; **ca** challenge author; **o** other

Figure 2.38 Text version x good vs. poor x type of strategy interaction: Year 2

The interaction in Figure 2.38 arises from differential use of re-reading and "other" strategies. With re-reading, good learners use this much more frequently with the version 1 texts while poor learners re-read more often with the version 2 texts. Good learners also use "other" strategies frequently with version 1 texts while poor learners use them mostly with version 2 texts.

Taken together, the interactions with year 2 texts seem mainly caused by the version 1 unfamiliar text. Negative general monitoring was more frequent with this text. Good learners tended to have more negative general monitoring with the version 1 texts and also re-read and used other strategies more frequently with the version 1 unfamiliar text. In contrast to year 1, comprehension ratings were not affected by the materials in year 2. Only one main effect was found with the third year materials; version 2 texts (mean 3.7) were rated higher than version 1 texts (mean 2.9).

Discussion

The main findings were that good learners outperformed poor learners in terms of strategy use; the range of different strategies used; and the number of inferences generated. Furthermore, both groups made more inferences as they gained more study experience and with familiar texts. In contrast, no evidence of a qualitative change in strategy use was found. Neither hypothesis for comprehension monitoring was supported: good learners did not monitor comprehension more frequently than poor learners; and monitoring was greater with unfamiliar texts and not with familiar texts as predicted. Finally, some evidence of greater self-regulated reading by good learners was found: good learners used more low-level strategies to overcome comprehension failure with the second-year (and possibly third-year) unfamiliar text.

2.15 Comprehension strategy use and inferencing The central argument with regard to strategy use was that differences in learning ability will be reflected in the strategies people use when reading. Evidence suggests that more able learners will use a greater number of strategies (Loranger, 1994) and also a greater range of different strategies (Baker, 1985) compared to less able learners. These findings were replicated in this experiment. The use of a greater range of different strategies represents greater "*flexibility of thought ... that can affect learning and thinking in a critical way*" (Weinstein, 1987, pp 593). Flexibility in strategy use can enhance the ability to overcome comprehension failure. For example, when confronted with comprehension failure a more able reader may re-read a difficult section of text, and if this does not enhance understanding, a different strategy can be used such as trying to identifying the source of confusion. This more flexible approach increases the likelihood of overcoming comprehension failure. In contrast, a less able reader may use the same unsuccessful re-reading strategy, but when understanding is not forthcoming they are more likely to give up, and possibly attribute the negative affect internally, such as a lack of ability (Fischer & Mandl, 1984). This more flexible approach to strategy use is an important characteristic of self regulated reading which will be discussed shortly.

Evidence also suggests that strategy use increases with study experience (Watkins & Hattie, 198; Bartling, 1988; Jacoubeck & Swenson, 1993). A trend for this was found in the present study but the main effect just missed significance. More specifically, evidence from longitudinal studies suggest a qualitative change in strategic behaviour takes place rather than just a general increase in the numbers used. Watkins & Hattie found that older learners reported using more elaborative processing and synthesis-analysis strategies - all high-level strategies from Schmeck's Inventory of Learning processes (ILP). Bartling found that learners with more study experience had lower scores on the study methods scale but higher scores on the synthesis-analysis scale of the ILP. More recently Jacoubeck & Swenson found that more experienced learners used deep and elaborative processing strategies more frequently but fact retention strategies less frequently. These studies suggest a qualitative change in strategic behaviour takes place; an increase in study experience is accompanied by more frequent use of high-level strategies but less frequent use of low-level strategies. One problem with these studies is that *reported* measures of strategy use were used. Students may report the strategies they think they *should be* using rather than the strategies they actually use; or they may report strategies they believe they use but in fact do not use. So these students may report using high-level strategies as they gain more experience, but may not actually do so. The problems of using reported rather than observed measures of strategy use are discussed in more detail in chapter 5.

Exactly what underpins such a qualitative shift in strategic behaviour is unclear. Watkins & Hattie (1981) believe it may be due to an increased exposure to different styles of study from different departments and different lecturers; and perhaps also to the different demands of assignments and exams in that more sophisticated arguments are usually required as students become more experienced. Taking a different approach, Alexander, Murphy, Woods, Duhon and Parker (1997) suggest a qualitative change in strategy use arises because students become more knowledgeable, and the facilitative effects of prior knowledge lead to a decrease in the use of low-level text-based strategies and an increase in high-level strategies concerned with identifying main ideas and constructing richer representations of the text.

However, in this experiment no evidence of a qualitative change in strategy use was found. Interactions between the effects of year, text and the type of strategy were found only with good learners who used re-reading and "other" strategies more frequently with the second year unfamiliar text. Closer inspection of the "other" strategies revealed this was the strategy of identifying unfamiliar terms. Furthermore, good learners used more strategies to overcome comprehension failure when reading this particular text. Taken together, these findings suggest that good learners tried to overcome their comprehension failure of the second year unfamiliar text by re-reading some sections and trying to identify what terms and words they did not understand. However this is evidence of greater self-regulated reading and not a qualitative change in strategic behaviour.

Recalling prior learning was the only strategy that increased with experience; it was used infrequently by both groups in years 1 and 2, but more frequently by good learners with the third year familiar texts. Recalling prior learning involved statements such as "*we did this last term in cognitive psychology*" or "*when I'm reading this I'm thinking of my A-level notes 'cos I've done Treisman before*". It's not surprising to find that this strategy increases with experience; by their final year the learners will have come across the topic of the text before - although the actual content of the text will be new to them. However, simply recalling prior learning will not enhance understanding as the learners are simply commenting on the fact that the topic of the text is familiar. Taken together these findings offer no evidence of a qualitative change in strategy use with experience.

The strategy most frequently used in this experiment was inferencing. On average good learners made 19 inferences compared to re-reading segments of the text 4 times. Similarly, on average poor learners made 7 inferences compared to re-reading segments of the text twice. The finding that good learners made more inferences than poor learners suggests that the ability to make inferences underlies good learning. If true, this contrasts with Recht & Leslie's (1988) finding that prior knowledge can compensate for learning ability, although the authors measured learning ability in terms of intelligence rather than exam performance. Good learners also made more inferences than poor learners with *unfamiliar* texts suggesting that learning ability (in terms of exam performance) can facilitate inferencing even when prior knowledge is lacking. Furthermore, inferencing increased with experience; warranted inferences were more frequent with familiar texts; and unwarranted inferences were more frequent with unfamiliar texts. Taken together the findings show the facilitative effects of inferences on learning (Chi, de Leeuw, Chiu & LaVancher, 1994). In contrast, when learners don't have the background knowledge - and the richer set of constraints that accompanies that knowledge - they are more likely to make inferences that are not plausible.

The question of interest is what underlies the good learners' superior inferencing skills? For example, do good learners simply have *more* (or more organised) background knowledge, or do they construct different types of representation when reading and while doing this they generate more inferences? These questions are investigated in chapter 6 when the types of representations constructed during reading are investigated with written summaries; and prior knowledge and memory for the text are investigated with devised questions.

Finally, text familiarity was expected to inhibit strategy use because strategies are more likely to be used when comprehension problem arise, such as when a reader's background knowledge is insufficient (Bereiter & Bird, 1985). While no main effect of text familiarity on strategy use was found, good learners did use low-level strategies (re-reading and identifying unfamiliar terms) more often when trying to overcome comprehension problems with the unfamiliar second year text. With unfamiliar texts, both groups took longer to read them and made more unwarranted inferences. Furthermore, in the next section I will show that monitoring was greater with unfamiliar texts, and that comprehension ratings were lower. Both of these findings indicate learners had poorer understanding of unfamiliar texts.

2.16 Comprehension Monitoring and self-regulation Studies of monitoring in the 1970's and early 80's typically found that good readers were better at monitoring than poor readers (Brown & Smiley, 1977). However, more recently Pressley & Ghatala (1990) argue that earlier studies often used materials and tasks that were not ecologically valid:

> *"... the more the situation approached text processing such as that demanded in the real world of school, the more obvious the monitoring and processing deficiencies, with results of (our) recent study providing a striking illustration of how inefficient adult reading and study of text can be." (pp 29)*

Earlier studies of monitoring often used the error detection paradigm pioneered by Markman (1977) with failure to detect an inconsistency in the text as a measure of poor monitoring.

However, other explanations can account for the failure to detect inconsistencies in texts; such as lacking prior knowledge, or noticing the error but not reporting it because of the mistaken belief that printed text could not contain errors (Winograd & Johnson, 1982) More recent measures have focused on learners' perceptions of performance, for example, how well learners believe they have answered given questions (e.g. Gaultney, 1995; Pressley & Ghatala, 1988). This movement towards using texts and tasks like those encountered in "real life" learning situations can explain why skilled readers are often found to be deficient at monitoring their comprehension.

In this experiment monitoring strategies were classed as any explicit comments about comprehension in general (i.e. neutral monitoring comments); successful comprehension (i.e.. positive monitoring comments); or comprehension failure (i.e. negative monitoring comments). The findings were that: monitoring was greater with unfamiliar than familiar texts; negative monitoring was more frequent than positive or neutral; and general monitoring was more frequent than specific. This shows that most monitoring consisted of comments about a general lack of understanding when reading unfamiliar texts. No monitoring differences between good and poor learners were found - but perhaps this is not surprising. According to Pressley & Ghatala (1990) *"one of the most salient and replicable findings in our research is a low correlation between intellectual ability and monitoring competency. Adequate monitoring can be observed across a range of abilities - so can inadequate monitoring."* (pp 30). So there may be no valid reason to expect learners who perform well in exams to monitor their comprehension any better than learners who perform less well. Unlike generating inferences and using strategies, monitoring may not be associated with academic ability.

Monitoring plays an important role in the self-regulation of strategy use as successful monitoring alerts the reader to comprehension breakdown, and strategies can then be used to overcome the source of confusion. Evidence in the early 1980's suggested good and poor learners respond differently to comprehension failure. For example, Fischer & Mandl (1984) found poor readers tended to personalise comprehension breakdown with negative affect believing their failure to comprehend validated their negative feelings about their learning ability, and consequently made no effort to cope with the difficulty. In contrast good readers tended to monitor their progress, and use this information in future learning situations. But the more recent findings of Pressley & Ghatala, discussed above, cast doubt on this claim, perhaps because it is observed so infrequently.

The findings from this experiment were that good learners used more strategies with negative monitoring when reading the second year unfamiliar text and the third year familiar text. Also, the good learners used the strategies of re-reading and identifying unfamiliar terms more frequently with the second year unfamiliar text, indicating that good learners used these strategies to overcome comprehension breakdown. The greater use of re-reading and identifying unfamiliar terms when trying to overcome comprehension failure is said to be characteristic of experts rather than novices. For example, Bereiter & Bird (1985) found experts re-read difficult sections of text to overcome comprehension failure. Furthermore, Pressley & Afflerbach (1995) classed "attempting to determine the meaning of words not understood or recognised" as a constructive response characteristic of expert readers. Identifying unfamiliar terms or words can be said to be the first step in this constructive response, but should probably be followed by attempts at a definition to be truly characteristic of expert behaviour. So it seems that good learners - at least with this second year unfamiliar text - increased the use of these low-level strategies to enhance their understanding. When reading the third year familiar text, comments about poor comprehension were accompanied by comments about which parts of the text were familiar. However, there was no attempt to use more strategies to overcome the poor comprehension. These findings support the proposals of Bereiter & Bird (1985): strategies are more likely to be used when comprehension problems arise i.e. when reading the second year unfamiliar text where background knowledge was insufficient rather than when reading the more familiar third year text; and also that good learners responded to comprehension failure more successfully than poor learners.

Why differences were found only with these 2 texts, and not with others is unclear. The lack of self-controlled strategy use in the first year is not too surprising as all students probably lack prior knowledge, metacognitive skills and experience at reading expository texts at an undergraduate level. However by the second and third years these skills are developing - particularly with good learners - and can be used to facilitate self-regulation. A lack of negative monitoring with familiar texts is also feasible as learners are less likely to encounter comprehension problems with familiar texts, and thus less likely to use strategies (Bereiter & Bird, 1985). Although good learners had more negative monitoring when reading the third year familiar text, the sample size for this analysis was very small (n=7) so the findings are specific to this small group of learners. Most puzzling is why good learners used more strategies with comprehension failure with the unfamiliar text in the second but not third year. Most instances of negative monitoring occurred with the second and third year unfamiliar texts and the mean number of strategies used with negative monitoring was very similar for the second year (good 7, poor 1) and third year (good 7, poor 2) texts. One explanation is that only 8 good learners were included in the analysis of the third year texts whereas 10 good learners were included in the second year analysis. With such small subject groups the loss of 2 subjects could lead to the loss of a significant effect. One final concern is that the materials used affected the outcomes, and the inconsistent findings in self- regulation may result from this confound.

2.17 Effects of the materials No main effect of the materials was found with any of the measures suggesting that no individual text differed significantly from the others. However, some interactions were found. In the first year, the unfamiliar version 2 text on "text representations" appeared to stimulate the monitoring and strategy use of good learners. With this text, good learners had more frequent general, negative monitoring and also re-read the text quite frequently and asked questions. In contrast their use of "other" strategies decreased. Both groups rated their comprehension of the version 2 texts lower than the version 1 texts suggesting they found the version 2 unfamiliar text more difficult to understand than the version 1 familiar and unfamiliar texts. In the second year, the unfamiliar version 1 text on "mental imagery" appeared to stimulate the monitoring and strategy use of good learners. With this text, good learners had more general, negative monitoring and also re-read and identified unfamiliar terms more frequently. Finally, the third year materials only seemed to affect comprehension ratings as version 2 texts were rated higher than version 1 texts.

Why these particular texts affected monitoring and strategy use is not clear. Each text was matched in terms of word length and readability. One explanation is that the authors writing style may make some texts more accessible and thus more understandable than others. However, this explanation can be ruled out as the both first-year familiar texts were taken from the same psychology textbook as were both first-year unfamiliar texts; also all 4 second year familiar and unfamiliar texts were taken from the same psychology textbook book to eliminate differences due to the authors style of writing. Yet the second year unfamiliar text on *mental imagery* still stimulated monitoring and strategy use while the second-year unfamiliar text on *lexical decomposition* did not. Good learners had nearly three times as much general negative monitoring attempts to overcome comprehension failure by using re-reading and identifying unfamiliar terms were two and a half times greater with the former text. One possible explanation is that the *content* of the texts caused the differences. For example, the text on mental imagery used a computer programming analogy to illustrate mental images as 2 dimensional arrays, but without an understanding of computer programming this analogy would not be helpful. It seems reasonable to conclude that as the word length, readability and the authors writing style were matched across the text, the content of the text probably caused the effects described above.

2.18 Measures of learning ability The overall findings from this experiment were that exam performance is a better measure of learning than reported LASSI ratings. Reported LASSI ratings could not distinguish learners with high from learners with low exam scores. One possible explanation for these finding relates to Bartling's (1988) suggestion that responses to learning inventory items may reflect little more than *feedback on previous and current exam performances* rather than the students actual study habits. Bartling found postdictive and concurrent validities of reported ratings were higher than predictive validities. Similarly, in this experiment LASSI ratings from year 3 (concurrent and postdictive validity) correlated with final exam scores while LASSI ratings from year 1 and from year 2 (predictive validity) did not. This supports the argument that students' perceptions of how they learn are strongly influenced by **feedback** on how well they perform in exams. With time, students may come to interpret their study behaviour with a central reference to exam performance and feedback on exam performance.

Just how feedback can effect learning has been investigated by Schmidt & Bjork (1992) (see section 1.2). The authors found that frequent feedback during training can enhance initial performance at acquisition, but can also hinder later performance at retention because trainees have not explored problems and used error detecting methods while training and these strategies can enhance longer term learning. This argument is not that far removed from Bartling (1988) proposal that feedback on exam performance can dominate the students' perceptions of themselves as learners to such an extent that students begin to use this feedback as an indicator of how successful they are as learners. Because feedback on exam performance can become the students main indicator of learning ability, there is the potential for this feedback to hinder longer term learning as other aspects of study behaviour, such as information processing skills, concentration techniques, self-testing, comprehension monitoring and self-regulation of performance, are given less importance. Thus feedback can degrade longer term learning - if it inhibits students from exploring and using other important learning strategies that enhance longer term learning.

In conclusion, the overall picture emerging from this experiment is similar to that proposed by Simpson (1984); most students use a restricted range of strategies when reading; rely heavily on the re-reading strategy; and often fail to self-regulate their reading. Furthermore, no evidence of a qualitative change in strategy use with experience was found. On a more positive note, students who perform well in exams use more strategies, and use a greater range of strategies and also generate more inferences than poorer students when reading. Evidence of self-regulated reading begins to emerge with good learners in their second (and probably) third year, as they try to overcome comprehension failure in a manner that is more characteristic of experts than novices. However, no evidence of a link between monitoring competency and exam ability was found. It seems that good learners are just as likely to monitor their comprehension as poor learners, but with experience, good learners become more proficient at overcoming comprehension breakdown.

Finally, learners' self-report responses were found to be less effective than exam performance at distinguishing good from poor learners. This may arise because students perceptions of their learning ability have been strongly influenced by feedback on past exam performance (Bartling, 1988); and this feedback may inhibit exploration of other study strategies that enhance long term learning. The superiority of exam performance over reported ratings in this experiment suggests there is a sizeable discrepancy between the students' *perceptions* of exam performance and their *actual* exam performance. For this reason, exam performance is adopted as the measure of learning for the rest of this thesis.

Chapter 3
Motivation

3.1 Aims of the motivation study The verbal protocols experiment in chapter 2 found that good learners outperformed poor learners with the number and range of strategies used and made more inferences when reading. Good learners also self-regulated their reading more efficiently when reading some of the texts. The rest of this thesis attempts to find out what characteristics may underlie the good learners' superior performance. The aim of this chapter is to see whether good learners may have been more **motivated** than poor learners when reading and therefore used more strategies to get a better understanding of the texts and also used more strategies to overcome comprehension failure. Evidence suggests that well motivated learners have a great incentive to work hard, be self-disciplined and manage their workload more efficiently than learners who are poorly motivated (Weinstein, 1987). The first prediction in this study is that good learners will be more motivated than poor learners. To investigate whether motivation **increased with study experience**, the motivation scores from the Learning and Study Strategies Inventory (LASSI) in the first, second and third years are analysed. To investigate **different aspects of motivation** the students are given the Motivated Strategies for Learning Questionnaire - or MSLQ - (Pintrich, Smith, Garcia & McKeachie; 1991) in their third year. Pintrich and his colleagues have developed a general *expectancy-value model of motivation* upon which the MSLQ is based. This model explains the relationship between 6 general constructs of motivation and achievement. These 6 general constructs are: student goal orientation; task value; student efficacy, control and outcome beliefs; perceptions of task difficulty and perceived competence; test anxiety and affect; and expectancy for success. Of particular interest to this study is the effect of these constructs on academic performance.

Figure 1.1 in the introduction shows that **goal orientation** and **task value** form the second pathway in Pintrich et al's model of motivation, and both can be seen to influence achievement. Students with intrinsic goals (i.e. motivated by curiosity, learning and interest) are more likely to have high levels of task value than students motivated by extrinsic goals (i.e. motivated by getting good grades or competing with others). Thus, students motivated by interest, curiosity and challenge are more likely to find tasks challenging and enjoyable. However, how these components affect achievement is less clear as the interaction between student goals and task value is dynamic and their effects on achievement are difficult to tease apart. For example, a student can be motivated by curiosity, find a task enjoyable and interesting, spend a lot of time reading for the task and yet still fail to incorporate the new knowledge into a successful project. Thus, whether or not well motivated learners achieve good grades in exams depends on these other factors. My tentative prediction therefore, is that good learners will be more likely to report intrinsic goals and high task value whereas poor learners will be more likely to report extrinsic goals and low task value.

One of the questions in this study is whether a positive relationship exists between **control beliefs** and achievement. Evidence suggests that students who attribute academic success to internal causes such as ability have higher achievement than students who attribute success to external causes such as task difficulty because students perceive themselves as having more control over their ability than tasks. Findley & Cooper (1983) suggest the relationship between control beliefs and achievement is mediated by age as the relationship seems stronger with young adolescents than with children or with university students and adults. Another mediating factor may be volition - or the intention to exert effort - students with internal control beliefs and who act with volition perform better than students with internal control beliefs who do not act with volition (Corno, 1986). Based on these findings a simple association between control beliefs and academic performance is not expected.

Evidence has also shown that a student's **efficacy beliefs** (i.e. beliefs about success or failure rather than actual success or failure) mediate future expectancies. Students who attribute success to internal causes such as ability should have higher expectations of future success than students who attribute success to external causes (such as task difficulty). However, the relationship between efficacy beliefs and achievement is mediated by other factors; intrinsic motivation has been found to strengthen the association while the use of deep processing strategies did not (Smith, Pintrich, & Doljanac, 1988). In this study a simple association between the efficacy beliefs and academic performance is not predicted.

High levels of **test anxiety** are negatively associated with expectancies for future success as students with high levels of anxiety often have lower expectations of success. However, the use of good learning and test taking strategies can mediate these negative effects (Tobias, 1985). A negative association between text anxiety and efficacy beliefs for future learning and performance is predicted with the learners in this study.

Finally, students with high levels of intrinsic goal orientation, task value and efficacy beliefs are more likely to use **cognitive and metacognitive strategies** when learning (Pintrich & Schrauben, 1992; Schultz, 1997). If the good learners in this study are found to have higher ratings for these motivation components, then I would also expect them use cognitive and metacognitive strategies more frequently when learning.

To recap briefly, the following predictions were made: good learners will be more motivated than poor learners; good learners will be more likely to report having intrinsic goals and high task value whereas poor learners will be more likely to report having extrinsic goals and low task value; text anxiety will be negatively associated with efficacy beliefs; no association will be found between control beliefs and exam performance; no association will be found between efficacy beliefs and exam performance; learners with high levels of intrinsic goal orientation, task value and efficacy beliefs will use more cognitive and metacognitive strategies.

Method

3.2 Subjects 13 good and 13 poor learners (identified from final exam scores) took part in this study. They were given the Motivated Strategies for Learning Questionnaire (MSLQ) in their third year of study. One poor student did not return the questionnaire therefore ratings from 13 good and 12 poor performers were available for analysis.

Materials (a) The 1991 version of the MSLQ is an 81-item self-report Inventory, which uses a 7 point Likert-type scale. For the MSLQ students were asked to rate how true a statement describes them, ranging from **1** (not at all true of me) to **7** (very true of me). The MSLQ contains three motivational scales: (1) *value components* of intrinsic goal orientation, extrinsic goal orientation, and task value; (2) *expectancy components* of control beliefs, self-efficacy and expectancy for success; and (3) the affective component of test anxiety. The MSLQ also contains a cognitive and metacognitive strategies scale which assesses the use of *strategies* such as rehearsal and self-regulation; and a *resource management* scale which assesses skills such as time and management and peer learning. Examples of MSLQ items are shown below and a full list of items is included in the appendix, table A3.1.

(a) In a class like this I prefer course material that really challenges me so I can learn new things. (intrinsic goal orientation)

(b) It is my own fault if I don't learn the material in this course. (control beliefs).

(c) When studying for this course I often try to explain the material to a classmate or friend. (peer learning)

(d) I expect to do well in this class. (self-efficacy)

The scales and their components are shown in Table 3.1 overleaf. Reliability and validity of the MSLQ was obtained with confirmatory analyses of the motivation items and of the cognitive and metacognitive strategy items. The authors indicated which items should fall into which factors, with estimates for the model specified and goodness of fit tested. Thus the 31 motivation items were tested to see how well they fit the six constructs (or factors) of motivation; and the 50 learning strategies items were tested to see how well they fit the nine constructs (or factors). The authors used Lambda-ksi estimates (LX) to estimate latent factors, with a value of .80 said to indicate well-defined latent constructs. Table 3.2 gives the LX estimates for the motivation items, the cognitive / metacognitive items, and the resource management items.

	Number of items
Part A. Motivation Scales	
1. Value Components	
a) Intrinsic Goal Orientation	4
b) Extrinsic Goal Orientation	4
c) Task Value	6
2. Expectancy Components	
a) Control Beliefs	4
b) Self-efficacy and expectancy for success	8
3. Affective Component	
Test Anxiety	5
Total Motivation Items	**31**
Part B. Cognitive Scales	
1. Rehearsal Strategies	4
2. Elaboration Strategies	6
3. Organization Strategies	4
4. Critical Thinking Strategies	5
5. Metacognitive Strategies	12
Total Cognitive Items	**31**
Part C. Resource Management Scales	
1. Time and Study Environment	8
2. Effort Regulation	4
3. Peer Learning	3
4. Help Seeking	4
Total Resource Management Items	**19**
Total Items (all three sections)	**81**

Table 3.1 Motivated Strategies for Learning Questionnaire Scales

The authors claim quite reasonable goodness of fit values for the MSLQ scales "*given the fact that we are spanning a broad range of courses and subject domains*" (Pintrich, Smith, Garcia & McKeachie, 1991 (p 79-80). It should be noted however, that more than half of the items had LX values of .69 or less: that is, 16 of the 31 motivation items and 39 of the 50 learning strategies. The scales with perhaps the lowest validity are metacognitive self-regulation and time and study environment: each having 75% of items with LX values of .56 or less.

Further validity was obtained from other tests of the goodness of fit: the chi - squared to degrees of freedom ratio (X^2 / df); the goodness of fit index (GFI); the root mean residual (RMR) and Hoelter's critical number (CN). The authors claim that a good fit of the model to the data is indicated by a X^2 / df ratio of less than 5; a GFI of .9 or greater; an RMR of .05 or less; and a CN or 200 or greater. For Motivation items: (X^2 / df) = 3.49; GFI = .77; RMR = .07; CN = 122. For Learning strategy items: (X^2 / df) = 2.26; GFI = .78; RMR = .08; CN = 180. Taken together, the goodness of fit tests suggest that the items do fit the constructs quite well, although the metacognitive self-regulation factor and the time and study environment factor may have the lowest validity.

Construct	Item	LX	Construct	Item	LX
Intrinsic Goal Orientation	1	.64	Rehearsal	39	.62
	16	.69		46	.63
	22	.66		59	.56
	24	.55		72	.58
Extrinsic Goal Orientation	7	.71	Elaboration	53	.60
	11	.58		62	.60
	13	.48		64	.74
	30	.44		67	.42
				69	.71
Task Value	4	.57		81	.65
	10	.64			
	17	.88	Organization	32	.57
	23	.86		42	.55
	26	.88		49	.45
	27	.84		63	.75
Control Beliefs	2	.57	Critical Thinking	38	.49
	9	.38		47	.76
	18	.84		51	.66
	25	.47		66	.74
				71	.67
Self-efficacy	5	.83			
	6	.70	Metacognitive self-regulation	33	.40
	12	.63		36	.44
	15	.71		41	.47
	20	.86		44	.54
	21	.89		54	.53
	29	.77		55	.58
	31	.87		56	.43
				57	.35
Test Anxiety	3	.60		61	.60
	8	.42		76	.61
	14	.62		78	.55
	19	.88		79	.50
	28	.76			
Time and study environment	35	.52	Peer Learning	34	.54
	43	.81		45	.82
	52	.52		50	.84
	65	.56			
	70	.64	Help Seeking	40	.20
	73	.37		58	.17
	77	.48		68	.90
	80	.40		75	.79
Effort Regulation	37	.53			
	48	.65			
	60	.52			
	74	.74			

Table 3.2 Lambda-ksi estimates for latent factors for MSLQ items.

Materials (b) A description of the LASSI was given in the introduction (section 1.2). Briefly, the LASSI is a 77-item self-report inventory which measures the use of learning and study strategies across 10 scales and uses a 5-point Likert-type scale. Students are asked to rate how typical a statement reflects themselves as learners ranging from **a** (not at all typical of me) to **e** (very much typical of me). In terms of the LASSI motivation scale, test-retest correlation coefficients found a high degree of stability (.84). The validity of the LASSI in general has been questioned, particularly when used with students considered to have weak study methods (Nist, Simpson, Mealey and Croc, 1990; Mealey, 1988). However, the motivation scale of the LASSI has been found to be the best predictor in terms of exam performance compared to the other LASSI scales (Albaili, 1997; Sinkavich, 1994).

Design and Procedure Three different types of analysis were undertaken. First, motivation scores from the LASSI were compared across the 3 years to see if motivation was affected by study experience. This involved one between subjects factor and one within subjects factor with repeated measures. The between subjects effect was **exam performance** and compared learners with the highest and lowest exam scores. The within subjects effect was **year of study** and compared motivation scores in years 1, 2 and 3. Second, analysis was carried out to investigate each of the 3 motivation scales and the 2 learning strategy scales from the MSLQ. This involved one between subjects factor of exam performance which compared good and poor learners. The 3 motivation scales were value components, expectancy components, and the affective component; and the 2 learning strategies scales were cognitive/metacognitive strategies and resource management strategies. Third, correlational tests were used to see if any of the MSLQ scales were positively associated with final exam scores.

At the beginning of the third year, the MSLQ's were mailed to 13 good and 13 poor learners. Instructions for completing the questionnaire were included, and the learners were asked to return the questionnaires within 4 weeks. Further prompting ensured that the questionnaires were returned by the end of the first term of the third year. However, one poor learner did leave the university without returning the questionnaire. The LASSI was completed by all of the learners at the beginning of their first year in a single session during class time. In the second and third years, the LASSI's were mailed to the learners. Instructions for completing the questionnaire were included and learners were asked to return the questionnaire within 4 weeks. All of the questionnaires were returned by the end of the first term.

Results

3.3 LASSI motivation scores The effect of year just missed significance (F=2.72, df 2,46, p.08) and arose because LASSI motivation scores tended to be lower in year 2 (mean = 29.9) than year 1 (mean = 31.2) or year 3 (mean = 31.4). No differences between the 2 groups was found (F=2.33, df 1,23) and no significant interaction (F<1). ANOVA tables of these mean scores, together with tables of all other measures are given in the appendix, tables A3.2 to A3.7.

3.4 MSLQ components of motivation The mean ratings from the MSLQ items for good and poor performers are shown as follows: **value components of intrinsic and extrinsic goal orientation and task value** (Figure 3.1); **expectancy components of control beliefs and self-efficacy** (Figure 3.2); **test anxiety** (Figure 3.3); **cognitive and metacognitive strategies** (Figure 3.4); and **resource management strategies** (Figure 3.5).

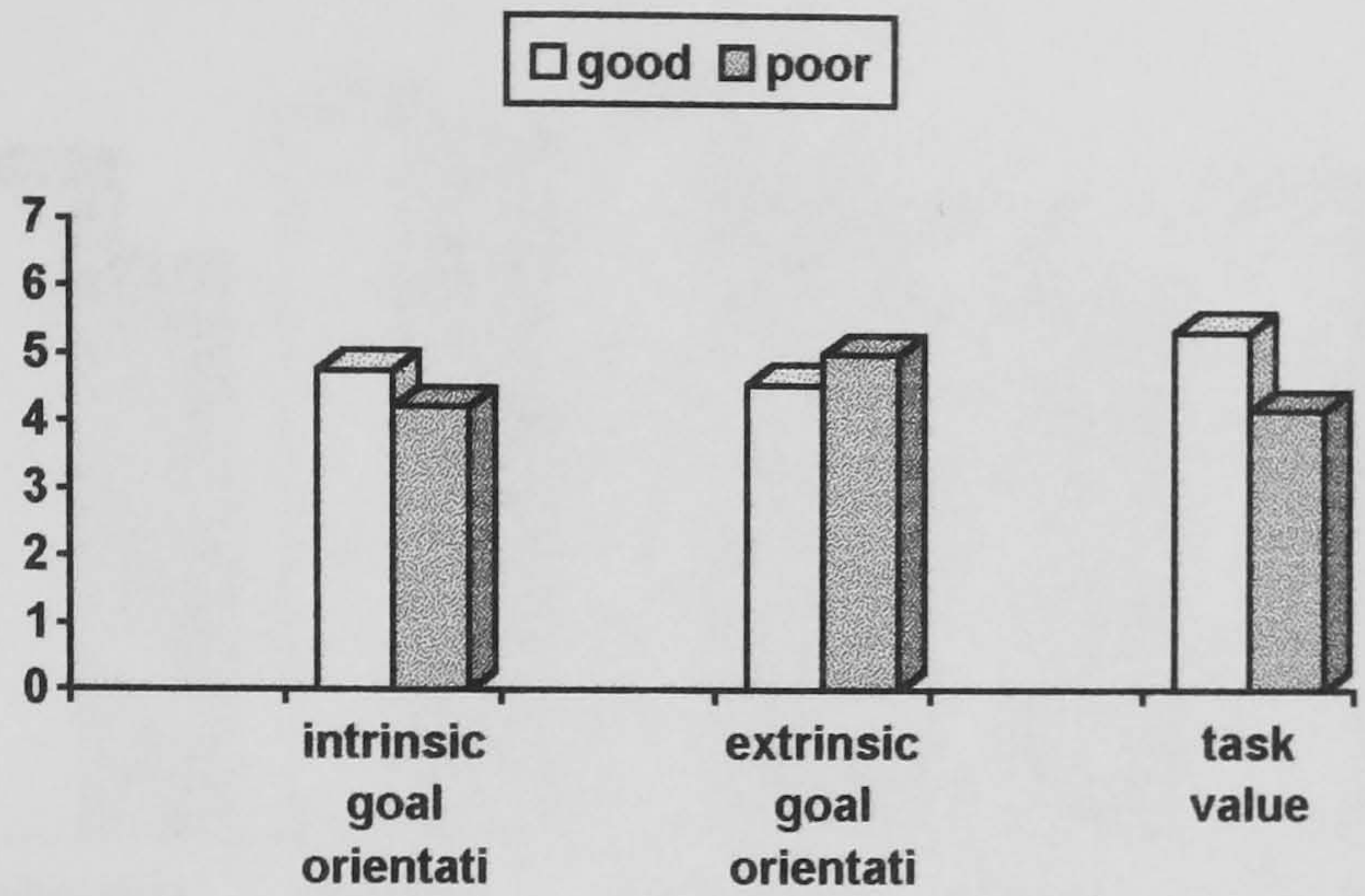


Figure 3.1 Intrinsic / extrinsic goal orientation and task value of good and poor performers.

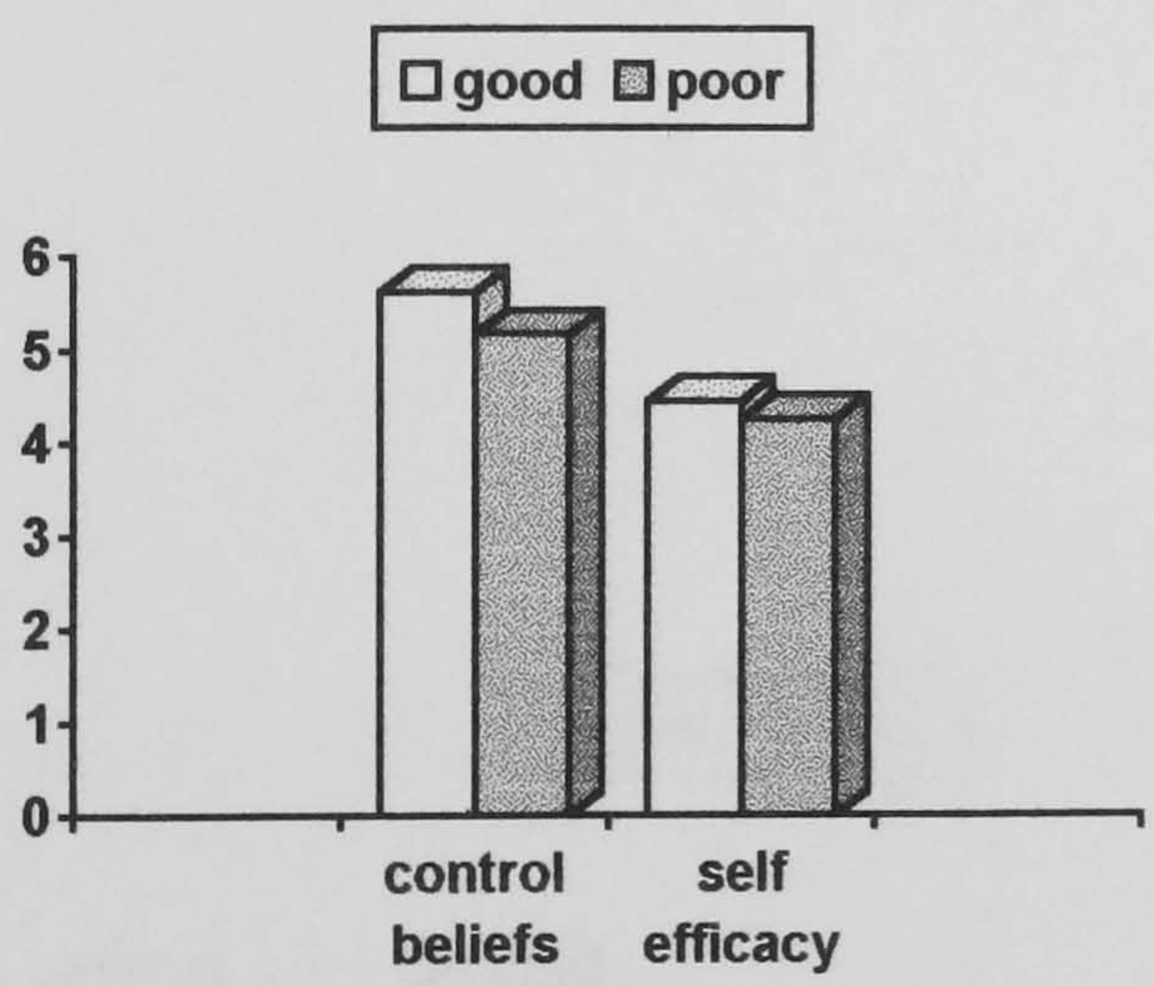


Figure 3.2 Control beliefs and self-efficacy beliefs of good and poor performers.

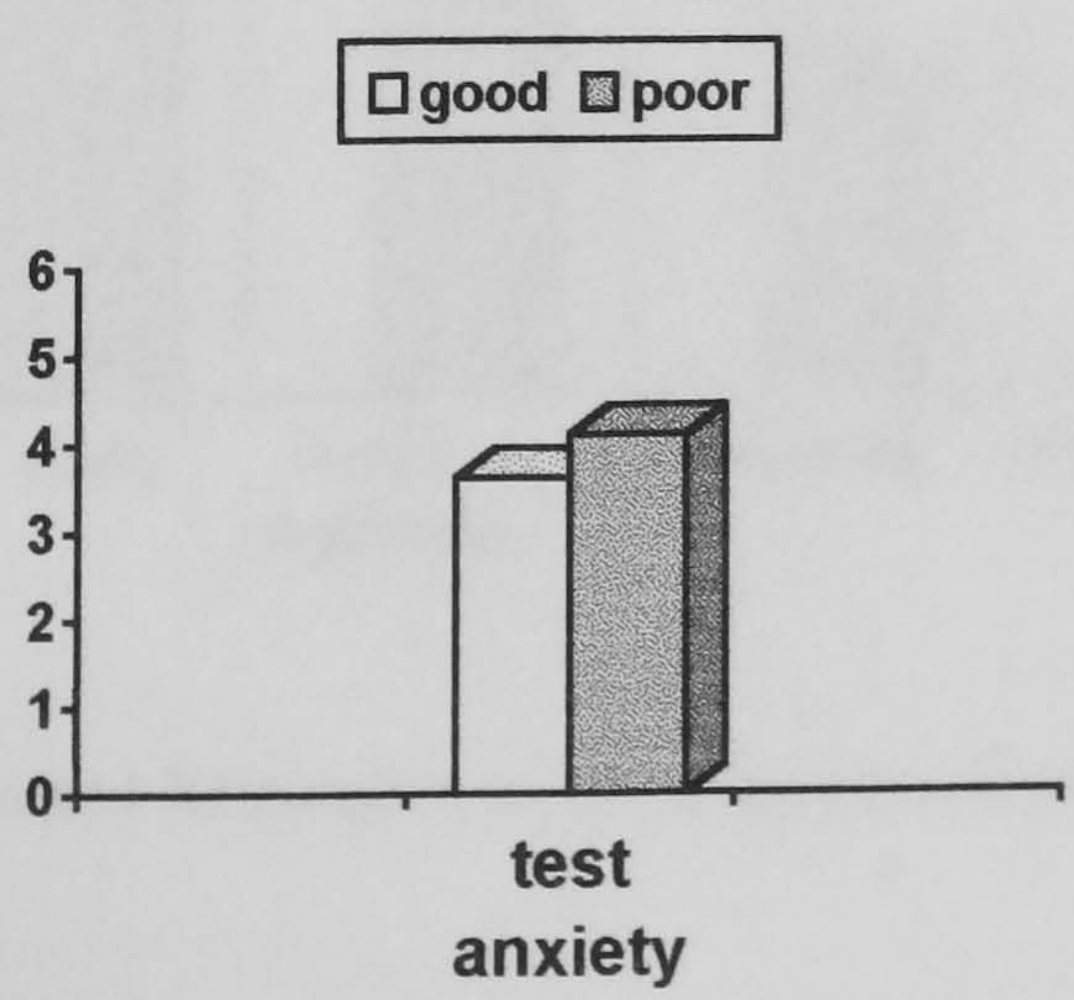


Figure 3.3 Test Anxiety of good and poor performers.

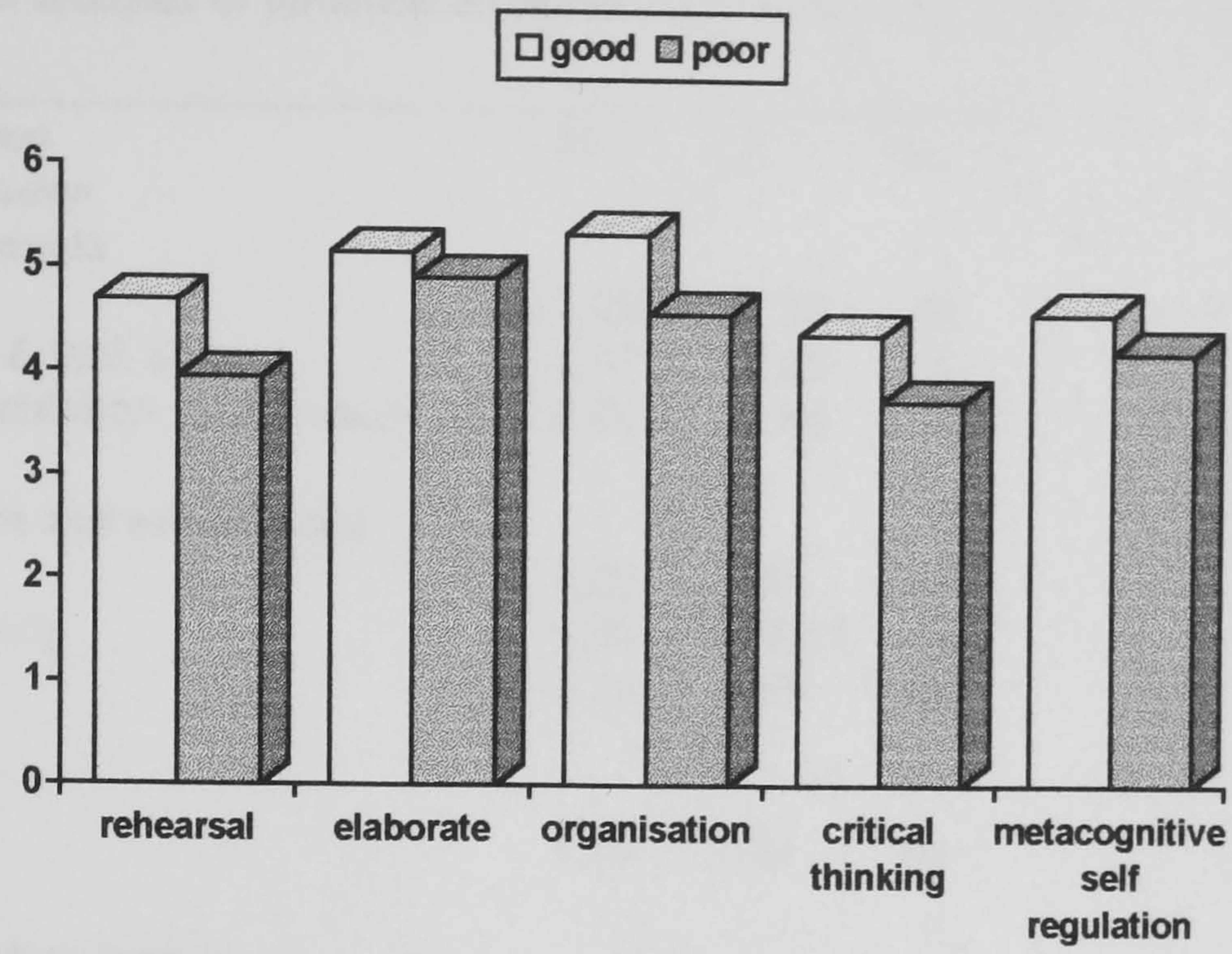


Figure 3.4 Cognitive and Metacognitive Strategies used by good and poor performers.

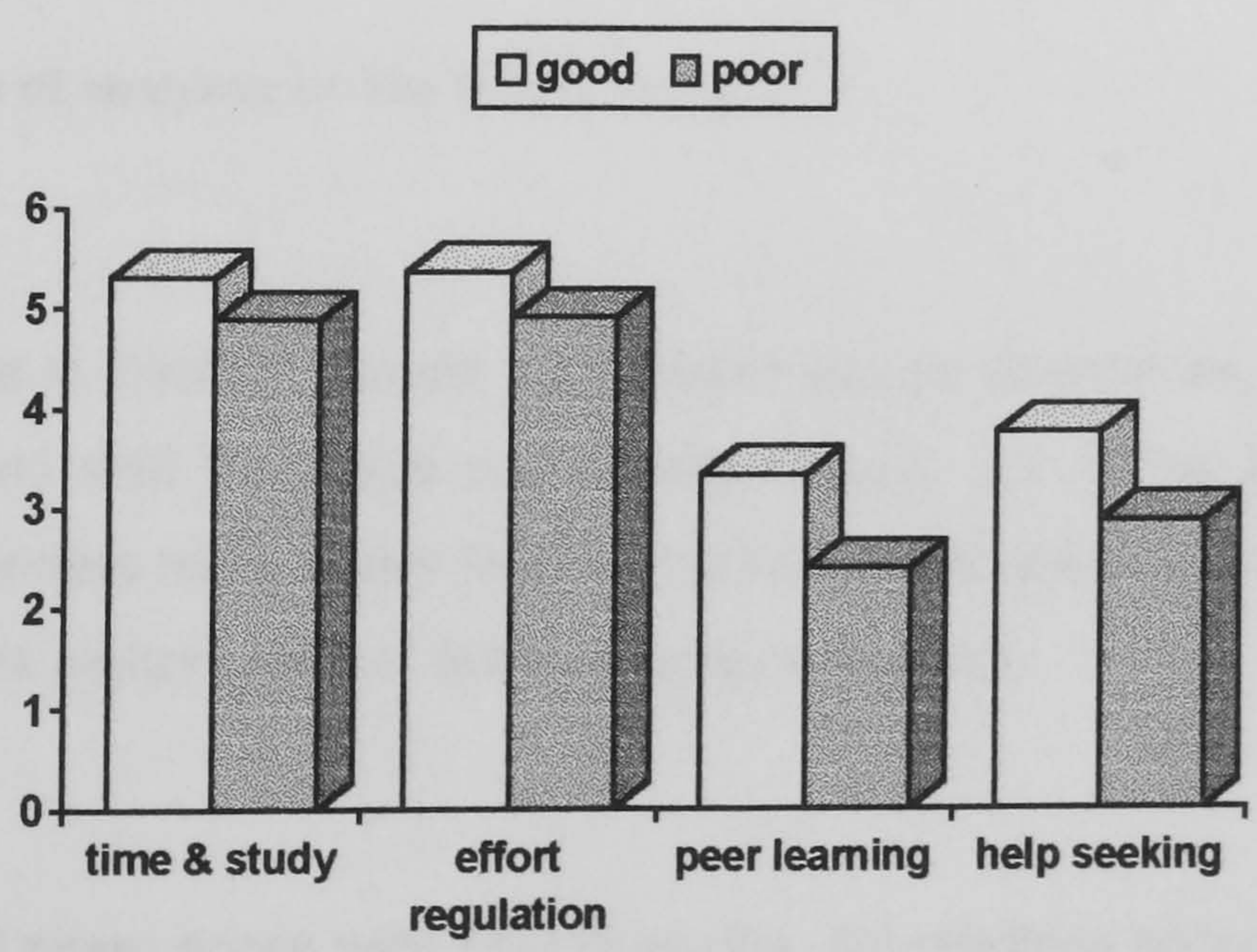


Figure 3.5 Resource Management Strategies used by good and poor performers.

The outcomes of analysis of variance on the MSLQ ratings are shown in Table 3.3

source of variation	**df**	**F**	**p**
(a) motivation scales			
(1) value components			
good vs poor	1,23	1.39	ns
goal orientation & task value	2,46	0.65	ns
group x goal orientation & task value	2,46	3.64	.03
(2) control beliefs and self-efficacy			
good vs poor	1,23	.87	ns
type of expectancy	1,23	22.11	.000
group x type	1,23	.33	ns
(3) test anxiety			
good vs poor	1,23	.54	ns
(b) learning strategy scales			
(1) cognitive / metacognitive			
good vs poor	1,23	2.88	ns
type of strategy	4,92	7.94	.000
group x type	4,92	.58	ns
(2) Resource Management			
good vs poor	1,23	3.03	.09
type of strategy	3,69	32.30	.000
group x type	3,69	.41	ns

Table 3.3 Outcomes of analyses on the MSLQ ratings.

Analysis on the data in Table 3.3 found no between groups differences. Only one significant interaction was found with the value components. Figure 3.1 shows this interaction arises because good performers have higher levels of intrinsic goal orientation and task value while poor performers have higher levels of extrinsic goal orientation.

3.5 Association of exam score with MSLQ scales Correlations between final exam scores and each of the MSLQ scales were then carried out. The outcomes of analysis are can be seen in Table 3.4 and show that 4 scales were positively correlated with exam performance: **intrinsic goal orientation; organisation strategies; peer learning and help seeking.** Higher ratings on these scales were significantly associated with higher exam scores.

MSLQ scale	exam performance	
	pearson r	p value
Motivation scales		
Intrinsic goal orientation	.40	**.04**
extrinsic goal orientation	- .32	ns
task value	.24	ns
control beliefs	.20	ns
self-efficacy beliefs and expectations	.06	ns
test anxiety	- .23	ns
Learning strategies		
Rehearsal	.08	ns
elaboration	.27	ns
organisation	.45	**.02**
critical thinking	.31	ns
metacognitive	.21	ns
time and study environment	.14	ns
effort regulation	.20	ns
peer learning	.43	**.03**
help seeking	.43	**.03**

Table 3.4 Correlations between exam performance and other motivation components.

3.6 Further investigation of intrinsic goal orientation Intrinsic goal orientation seems to be the best indicator of learning ability: it was strongly associated with exam performance; and was more characteristic of good performers while extrinsic goal orientation was more characteristic of poor performers. At this point in the study therefore, further analysis was carried out to see if intrinsic goal orientation was associated with: the use of strategies (cognitive, metacognitive, and resource management); efficacy and control beliefs; task value; and test anxiety. The outcomes of this analysis are shown in Table 3.5. Analysis revealed that: task value, control beliefs, efficacy beliefs, time and study management and help seeking were strongly associated with intrinsic goal orientation; as were the use of elaboration, organisation, critical thinking, and metacognitive self-regulation strategies. The only measures that did not correlate with intrinsic goal orientation were rehearsal strategies, test anxiety, effort regulation and peer learning.

	intrinsic goal orientation	
	pearson r	p value
Motivation component		
task value	.39	.05
control beliefs	.42	.03
self-efficacy beliefs and expectations	.42	.03
test anxiety	- .06	ns
Learning strategies		
Rehearsal	.31	ns
elaboration	.69	.000
organisation	.56	.003
critical thinking	.75	.000
metacognitive	.55	.004
Resource management strategies		
time and study environment	.42	.03
effort regulation	.32	ns
peer learning	.31	ns
help seeking	.44	.02
Exam performance	.40	.04

Table 3.5 Correlations between intrinsic goal orientation and other motivation components.

One further correlation was carried out to test whether test anxiety is negatively associated with self-efficacy beliefs; this prediction was supported ($r = -.50$, p .010).

Discussion

3.7 The main findings were that motivation did not increase with study experience but tended to be lower in the second year of study. *Intrinsic goal orientation* seemed to be the best indicator of achievement as learners with higher exam scores reported greater intrinsic goal orientation and task value while learners with lower exam scores reported greater extrinsic goal orientation. Intrinsic goal orientation was also positively associated with: exam performance; task value; control beliefs; efficacy beliefs; the use of elaboration, organisation, critical thinking and metacognitive self-regulation strategies; time and study management; and help seeking. Apart from differences in goal orientation and task value, no other differences in motivation were found between the two groups. The use of organisation strategies; peer learning and help seeking were also associated with higher achievement.

Several factors could explain the possible drop in motivation in the second year. In a debriefing session after the second year verbal protocols experiment several students stated that an increasingly hectic social life constrained their motivation to study: "*my motivation's dropped off because of everything else that's going on outside my study*"; "*I'm producing a play this term and my mind's been concentrating on that and I haven't been thinking about my work so much*". A lack of goal direction was also given as an explanation: "*I don't enjoy psychology as much as I used to and I'm not sure where my degree is going to get me whereas before I had just assumed that it was really good to have a degree, now I don't know whether I'm* *learning anything that's going to be ever useful*"; "*I think my motivation's changed for the worse because I'm not sure that I will get the marks I need to do Clinical Psychology, so I don't know what I want to do anymore*". Some students were brutally honest saying that laziness was the source of decreased motivation "*general laziness stops me from working, once I start I really enjoy it and will do it a lot, it's just getting started when you could spend another 5 minutes in bed*". If students don't put the effort into their work and then do poorly, they can avoid making 'lack of ability' attributions and so avoid damaging their self-worth. For example, students may miss lectures or not complete required tasks, and can then attribute ensuing failure to a lack of effort rather than a lack of ability. Some comments seem to reflect such failure avoidance goals (Covington & Omelich, 1979) in the second year of study; "*my motivation's worse because I've not done my work on time and haven't done much further reading. I can't force myself to do it .. I do a lot of sport and sit down and watch telly rather than do some work. I always find some excuse like I'll do it tomorrow.*"

These anecdotal comments highlight the complicated interaction between motivation and cognition in academic learning. Pintrich & Garcia (1994) stress that a student's ability to control their cognition, motivation and volition all dramatically affect learning, particularly with college students who "... *when you talk to them are very motivated and concerned about doing well but often have a very difficult time enacting their intentions, given all the internal and external distractions they confront in college life*" (pp 126-127). Such internal and external distractions are eloquently described by some of the students in this study and affect not only their motivation to learn, but also the way they regulate and control their learning, the strategies they use and their desire to work. Further research is needed to investigate how these components interact and how students can be helped to cope with such distractions.

The results of the present study suggest that **intrinsic goal orientation** is the best indicator of achievement. First, learners with high exam scores appear to be motivated by intrinsic goals such as mastery, challenge, learning or curiosity; while learners with low exam scores appear to be motivated by extrinsic goals such as grades, rewards, or approval from others. Second, intrinsic goal orientation was found to be positively associated with exam performance. These findings suggest that learners who view learning as a way of mastering challenging tasks and satisfying curiosity are also likely to perform well academically.

The way that intrinsic goal orientation enhances achievement is not fully understood. Students with intrinsic goal orientation are more likely to have high levels of task value (Pintrich & Schrauben, 1992; Harter, 1985). This was found in this study as task value and intrinsic goal orientation were more characteristic of good than poor learners; and task value was also positively associated with intrinsic goal orientation. Figure 1.1 in the introduction shows that student goal orientation and task value can both influence achievement. Eccles (1983) describes how tasks with high attainment value (i.e. challenging), intrinsic interest (i.e.

enjoyment) and utility value (i.e. successful at achieving goals) seem to influence a student's *involvement* with a task - but the effect on *achievement* is not clear. For example a student may find a task immensely interesting but spend so much time reading around the topic that he or she fails to complete the assignment successfully In this study no positive association between task value and exam performance was found suggesting that if task value does influence achievement, then other characteristics mediate this effect. Pintrich and colleagues recognise the need for further research into the way these components interact and influence academic achievement. Recent research suggests that children adopt different goals depending upon the nature of the task: adopting learning goals of mastery and challenge when they want to master a task and succeed; or adopting performance goals of getting good grades when they are more concerned with avoiding failure (Dweck & Elliot, 1983). The interaction between goals, task value and achievement is dynamic and the effects of these components on achievement are difficult to tease apart.

Students with intrinsic goal orientations were more likely: to have high levels of efficacy beliefs and control beliefs; to use cognitive and metacognitive strategies; to manage their time and study environment effectively; and to seek help with learning if necessary. Evidence has shown that **efficacy beliefs** (i.e. a student's beliefs about success or failure - rather than actual success or failure) mediate future expectancies. For example, students who attribute success to ability (i.e. I did well because I'm clever) will expect to do well in future exams because ability is presumed to be stable. In contrast, students who attribute success to effort (i.e. I did well because I worked hard) may have lower expectations for future success as effort is a less stable internal dimension than ability. Similarly, students who attribute success to external factors (i.e. I did well because the exam was easy) will also have lower expectations for future success as the level of difficulty of the exam is outside their control. Efficacy beliefs may also be associated with achievement, although other factors have been found to mediate the association. For example, intrinsic motivation has been found to strengthen the association while the use of deep processing strategies had the opposite effect (Smith, Pintrich & Doljanac, 1988). In this study efficacy beliefs were not associated with achievement which suggests that the attributions students' make about success or failure did not influence their academic performance. Being motivated by interest, in contrast, does seem to facilitate exam success. According to Pintrich and colleagues (1991) *"there is not a simple relationship between efficacy beliefs, task difficulty, expectancy for success and achievement behaviour .... and further research is needed to clarify these relationships in ecologically valid settings with ecologically valid tasks"*. (pp 56) For example, a student may believe he or she can perform well in a test, but expect to perform poorly because the test questions are known to be unpredictable or arbitrary. Thus, expectancy of success is lower than efficacy beliefs would normally predict because perceptions of task difficulty mediate efficacy beliefs. Again the dynamic interaction between efficacy beliefs and other components of motivation make it difficult to clarify the effects of efficacy beliefs on achievement.

Evidence for a positive relationship between **control beliefs** and achievement is equivocal. Findley & Cooper (1983) suggest there may be a curvilinear relationship between perceptions of *internal control* and achievement as associations have been found with young adolescents but not with younger children or with older university students and adults. In this study no association between control beliefs and achievement was found implying that students who believe they are in control of their learning are no more likely to perform well in exams than students who believe they have little control over their learning.

Taken together the findings so far suggest that students who are motivated by interest tend to believe they have control over their learning; and that students motivated by interest also tend to perform well in exams. However, students who believe they have control over their learning do not tend to have higher exam scores. The question of interest at this point is why control beliefs do not seem to influence achievement? Early research on control beliefs proposed that students who believed they were in control of their learning tended to have higher achievement. Internal attributions to ability and effort were believed better than external attributions to luck and task difficulty because students had more control over these internal causes. Other dimensions were later identified such as *stability* and *controllability* and have been shown to effect outcomes. Ability is a more stable attribute than effort, and therefore students who make ability attributions should have more positive expectancies for future success. Similarly, effort and mood are both internal, unstable causes, but effort is believed to be more controllable than mood, therefore students who make effort attributions should have more positive expectancies for future success. More recently however, the role played by volition - defined as '*purposively expending effort in an intentional manner*' (Pintrich et al, 1991) has been recognised. Evidence has shown that students who believe they have control over their learning - but also act with *intentionality* (i.e. the intention to exert effort) perform better than students who believe they have control over their learning but lack intentionality (Corno, 1986). The concepts of control beliefs and intention are now recognised as important motivational components and a lack of intention may explain why control beliefs were not associated with achievement in this study. University students must be self-motivated to do the set reading and keep up with assignments and a lack of intentionality would have a detrimental effect on both learning and achievement.

The general-expectancy value model of motivation places **test anxiety** close to efficacy beliefs because students' beliefs are assumed to influence test anxiety; and text anxiety is assumed to be negatively associated with expectancy for success. In this study a significant negative association between test anxiety and self-efficacy beliefs for learning and performance was found. Thus high levels of anxiety were associated with low expectations for future achievement, that is, the greater the amount of cognitive worry, the greater the expectancy of failure. However, the detrimental effect of anxiety on expectancy for success is characteristic of both good and poor performers as no between groups differences in test anxiety or efficacy beliefs were found. Furthermore high test anxiety was not associated with poor exam performance as no significant negative relationship between these components was found. These findings suggest that test anxiety influences expectancy for success but not performance which implies that the students in this study found ways of coping with the debilitating effects of anxiety when sitting their final exams. For example, if students use good learning and test taking strategies then cognitive demands are reduced so that any interfering anxious thoughts can be dealt with more effectively (Tobias, 1985). Another possible explanation is that the measure of learning used in this study - i.e. final exam performance - is less affected by anxiety than measures of learning used in other studies such as course grades. Darke (1988) found that anxiety did not effect students' ability to infer anaphoric relations - so perhaps the influence of anxiety on performance is mediated to some extent by the measure of learning. Test anxiety was rated lower than all other motivation components apart from peer learning and help seeking which suggests the students were not unduly anxious when completing the MSLQ. However, I suspect that final exams do create more anxiety than measures such as course grades and the MSLQ probably failed to detect this. If final exams are a particularly stressful measure of learning perhaps students are motivated to work more on their learning and test taking strategies, and as Tobias claims, this would allow them to deal more effectively with anxious thoughts.

The final MSLQ scales to consider in this chapter are the use of learning strategies and resource management strategies. Many researchers have found that goals alone do not ensure academic success as they need to be accompanied with the use of effective learning strategies; and furthermore, that knowledge of learning strategies alone is not sufficient to ensure academic success as students must have the motivation to use strategies. (e.g. Schultz, 1997; Weinstein & Meyer, 1985). Pintrich & Schrauben (1992) claim that students with intrinsic goal orientation, high task value and high self-efficacy beliefs "*are more likely to be cognitively engaged in learning through the use of cognitive and metacognitive learning strategies*" (pp 124). In this study however, no between groups differences were found with any of the learning and resource management strategies.

As intrinsic goal orientation is the motivation component most characteristic of good learners, the important question for this study is whether intrinsic goal orientation is positively associated with strategy use. Intrinsic goal orientation was positively associated with the use of: elaboration, organisation, critical thinking, metacognitive self-regulation strategies; time and study management and help seeking. In contrast, rehearsal strategies, effort regulation and peer learning were not associated with intrinsic goal orientation. While not being able to infer that the use of these strategies causes academic success, the association between intrinsic goal orientation and academic success and between intrinsic goal orientation and the use of the strategies outlined above suggests the dynamic interaction of these components equips students to perform well in academic situations. Schultz (1997) examined the relationship between educational goals and the use of learning and motivation strategies with a path analysis and concluded "*when educational goals were accompanied by .. the use of effective leaning and motivational strategies higher academic performance tended to occur* (p198 - 199).

In chapter 1 **rehearsal strategies** were shown to be low-level strategies that facilitate memorisation rather than learning (Spring, 1985) and it is not surprising to find they are unrelated to intrinsic goal orientation which has been shown to facilitate learning rather than memorisation (Dweck & Elliott, 1983). The lack of association between **effort regulation** and intrinsic goal orientation and between effort regulation and exam performance implies that being motivated by interest and performing well in exams is unrelated to a commitment to completing goals amidst difficulties and distractions. This is puzzling as one would expect students with intrinsic motivation to have the commitment to complete goals and that this commitment to complete goals would be rewarded with higher achievement. Perhaps the lack of association reflects the problems university students have in coping with the many distractions of college life, and that these distractions are common to most students, regardless of their intrinsic motivation and achievement level. If so this would support the claims of Pintrich & Garcia (1994): that students need help to *enact their intentions* and deal with the many internal and external distractions of college life. Or perhaps students with intrinsic motivation just use more effective strategies, so although they are just as distracted as other students, their learning is superior when they do work.

Finally, **peer learning** was not associated with intrinsic goal orientation but was associated with exam performance. In contrast, help seeking was associated with both intrinsic goal orientation and exam performance. The finding that peer learning is related to exam performance is understandable; students can benefit from peer learning as they are given the opportunity to compare ideas and rectify misconceptions in small discussion groups with peers. However this will not be beneficial if students merely reinforce each others misconceptions; for peer groups to be successful students must be able to explain ideas clearly enough so that those with problems can restructure their understanding and rectify misunderstanding (Johnson & Johnson, 1975). However, in the present study learners motivated by intrinsic goals seemed just as likely as students motivated by extrinsic goals to learn from their peers. One problem with interpreting the findings on peer learning and help seeking is that few learners reported using these techniques. Of all the MSLQ scales, peer learning and help seeking received the lowest ratings. This is quite worrying and suggests that either the students are unaware of the benefits of these techniques; or that the students are reluctant to use them. Further research is needed to investigate why the students used these techniques so infrequently and to introduce the students to the benefits of peer learning and help seeking.

In conclusion, the motivation components that seem to distinguish good from poor learners are intrinsic goal orientation and task value. Students who are motivated by interest and curiosity and who find tasks challenging and enjoyable tend to perform well in exams while students motivated by getting good grades and find tasks less rewarding tend to perform poorly in exams. However, how these goals interact and change as the students become more experienced is not known. With hindsight the MSLQ should have been given to the students in their first, second and third year to investigate developmental changes but the importance of this issue only became apparent as the thesis progressed rather than at the early stages when the design was being planned. The poor learners may have had a valid reason for pursuing extrinsic goals, for example, wanting to do well in relation to others at a time in their study when they are "*confronted with the adjustment to adult roles in relatively complex or competitive environments*" (Pintrich et al, 1991) I would therefore be cautious about extolling the virtues of intrinsic goal orientation for all students in all learning environments without having a better understanding of the developmental changes in goal orientations as students progress through university. One final comment is that the aim of this chapter was to gain an insight into the motivation differences of good and poor learners. While concluding that intrinsic motivation seems to be component most able to do this, I am concerned that the dynamic interaction of the components of motivation make it difficult - and probably unwise - to focus one component and disregard the others. However, in terms of Pintrich et al's expectancy value model of motivation, the **task value path** with the motivation components of student goal orientation and task value do seem to distinguish good from poor learners in terms of final exam performance.

CHAPTER 4

Metacognitive knowledge of strategies

4.1 Aims In the last chapter motivation was investigated as one of the characteristics that may distinguish good from poor learners. The main findings were that good learners were more likely to be motivated by intrinsic goals such as mastery, challenge or curiosity while poor learners were more likely to be motivated by extrinsic goals such as grades, rewards or approval from others. Furthermore, intrinsic goal orientation was positively associated with exam performance. However, as well as being *motivated to use* strategies students must have *explicit metacognitive knowledge* of strategies. The aim of this chapter is to investigate whether metacognitive knowledge of strategies distinguishes good from poor learners.

Motivation and metacognition are inextricably linked. Metacognition involves two related abilities. The first ability concerns *explicit metacognitive knowledge* of the states and processes of the mind - for example, metacognitive knowledge of strategies. Three types of explicit metacognitive knowledge have been identified: *declarative knowledge* about what a strategy is and why it should be learned; *procedural knowledge* about how to use the strategy; and *conditional knowledge* about why a strategy is important and in what situations it should be used (Paris, Lipson & Wixson, 1983). The second ability concerns the self-regulation or modification of these states and processes of the mind; for example, the self-control of strategy use. Thus metacognition involves both *self-awareness* (i.e. of strategies) and *self-control* (i.e. the deliberate and conscious control of strategy use). Evidence suggests that good readers are better than poor readers both in terms of explicit metacognitive knowledge (Spring, 1985) and self-control (Fischer & Mandl, 1984). In the verbal protocols experiment (chapter 2) self-control of strategy use was investigated by analysing strategy use following comprehension failure. Good learners were found to use more strategies to overcome comprehension failure when reading unfamiliar texts in the second, and probably the third year.

In this chapter *explicit metacognitive knowledge* is investigated by asking learners to report how frequently they use different strategies. This study is based on an experiment carried out by Carl Spring (1985) and a modified version of his reading strategies questionnaire is used. In section 1.6 of the literature review Spring's study was described. To recap briefly, 5 different factors were identified from reported ratings of strategy use: *verbal rehearsal*, *written rehearsal*, and *figural rehearsal* factors (which comprised low-level study strategies); and *understanding* and *critical reading* factors (which comprise high-level comprehension strategies). Spring found no difference between good and poor readers with *study strategies* although poor readers tended to use these strategies without initially trying to understand the material. More recently Pressley & Afflerbach (1995) make similar claims. They found that good readers used study strategies to focus on textual details but the main goal was to keep track of the main ideas. In contrast poor readers tended to use these strategies for remembering text details. Thus both groups report using study strategies with similar frequency, but their *motivational goals* appear to differ. With *critical reading strategies* no between groups difference was found, although this is perhaps not surprising given that these strategies are beginning to develop during college years, and not all students will use them effectively - if at all (Chall, 1983). However, a significant difference was found with understanding strategies; good readers reported using these strategies more frequently than poor readers. Spring concluded a positive relationship between explicit metacognitive knowledge of strategies and reading skill:

> *"... it is primarily strategies in the Understanding Factor that discriminate between good and poor readers. In fact, the comprehension strategies comprising the Understanding Factor were those which good readers reported they employed the most frequently. By contrast, poor readers reported that they employed the study strategies in the Verbal Rehearsal factor the most frequently. These results suggest that poor readers ... may rely heavily on study strategies without first having completely understood the text material to be studied." (pp 164).*

4.2 Predictions Based on this evidence the following predictions are made. First, good learners will report using high-level strategies - particularly Spring's understanding strategies - more frequently than poor learners. Second, no difference will be found with reported use of low-level study strategies. Third, both groups will report using high-level critical reading strategies infrequently.

Method

4.3 Selection of subjects Good and poor learners identified from final exam scores took part in this study. One poor learner failed to return the reading strategies questionnaire in the third year, therefore reported ratings from 13 good and 12 poor learners were used in the analysis.

Materials A modified version of Spring's (1985) reading strategies questionnaire was used to investigate reported strategy use. The questionnaire used in this study contains the 8 study strategies and 7 comprehension strategies used by Spring, as well as an additional 7 strategies. The 8 study strategies were re-reading, underlining, asking questions, restatement, taking notes, making an outline, summarising, and drawing diagrams. The 7 comprehension strategies were relating the text to prior knowledge, looking for logical relations, identifying important points, relating the text to beliefs, to experiences, and to emotions, and thinking about how the material could be used. The 7 additional strategies were all identified as high-level constructive strategies by Pressley & Afflerbach (1995) in section 1.4 of the literature review; monitoring comprehension, relating text segments to get the gist, challenging the author, predicting future content, reading ahead to rectify a miscomprehension; identifying and defining unfamiliar terms or content. Thus the reading strategies questionnaire used in this study contains 8 low-level study strategies and 14 high-level comprehension strategies. Examples of reading strategies are shown below; the full questionnaire is given in the appendix, table A1.1.

Reread some of the material. (*study strategy*)
Relate the material to what I already know. (*comprehension strategy*)
Monitor the success or failure of my comprehension. (*additional high-level strategy*)

Design and Procedure Analysis of the reading strategies involved one between subjects factor and one within subjects factor. The between subjects factor was **exam performance** and compared good and poor learners. The within subjects factor was **year of study** and compared ratings across the 3 years of study.

Each student received a different random order of the items. The students were asked to rate how frequently they typically used each strategy to learn from a textbook. A 3-point Likert type scale was used: **1** (I do not use the strategy); **2** (I sometimes use the strategy); and **3** (I frequently use the strategy). In the first year the students completed the reading strategies questionnaire in a single session during normal class time. The experimenter explained the rating scale and required responses, after which the students completed the questionnaire. In the second and third years, the questionnaires were mailed to students along with instructions for completing the questionnaire. The students were asked to return the questionnaire within the next month. Further requests ensured that the questionnaires were returned by the end of the term. The following instructions were given at the head of each questionnaire:

> *"Below is a list of statements that describe a number of strategies people may use when reading. Please read through all of the statements once. Then read them a second time and indicate how often you typically use each one while learning textbook material.* ***Please indicate what you actually do and not what you think you should do.*** *Indicate your frequency of usage by circling one of the numbers printed next to each statement."*

Results

Analysis Analysis of the reported ratings of strategy use was carried out in 3 different ways. First, the technique of cluster analysis is used to look for evidence of categorisation of the reported strategies. This technique clusters items so that items within a cluster are more similar than items from different clusters. Clusters indicate that, for example, if a student has a high score on one element of a cluster then he or she will also have a high score on the other elements of that cluster. In terms of this study, the 22 reading strategies will be clustered according to the similarity of the frequently ratings. Clusters are formed by grouping items into larger and larger clusters, until all of the items are members of a single cluster. First the proximities (or 'nearness') between the individual items are calculated. Then the two nearest items are combined to form a new cluster. Then the proximities are recalculated between the new cluster and the remaining items. This process is repeated until all items have been combined into a single cluster.

Second, analysis was carried out on the emerging clusters to investigate the use of strategies from different clusters. Analysis of these clusters involved one between subjects factor and one within subjects factor with repeated measures. The between subjects factor of **group** had 2 levels which were good and poor learners identified by exam performance. The within subjects factor of **year of study** had three levels which were year 1, year 2 or year 3.

Third, analysis was carried out on each individual cluster to investigate the use of strategies within in each cluster. This involved the between subjects factor of **group** and the within subjects factor of **year of study**, described above.

The analysis is reported in 3 stages. In stage 1, the results of cluster analysis are reported and the emerging clusters identified. In stage 2 analysis of the identified clusters is undertaken to investigate the use of strategies from different clusters. In stage 3, each cluster is analysed separately to investigate the use of strategies from within each cluster.

4.4 Cluster analysis of reported reading strategies The dendrograms for good and poor learners in the first, second and third years are shown in Figure 4.1, 4.2 and 4.3 respectively. Figure 4.1 shows that 2 clusters emerged from the first-year reported ratings. Cluster 1 contains 9 strategies; making an outline, summarising, restatement, re-reading, taking notes, defining terms, identifying terms, identifying important points, and underlining. Cluster 2 contains 12 strategies: linking text to emotions, beliefs and experiences; using the information in other contexts, linking text to prior knowledge, looking for logical relations, getting the gist, asking questions, monitoring comprehension, predicting future content, drawing diagrams and challenging the author. Reading ahead does not cluster with other strategies.

Figure 4.2 shows that 2 clusters emerged from the second-year reported ratings. The strategies in these clusters were identical to those found with the first year ratings apart from: *linking text to prior knowledge* (with cluster 2 in the first-year but with cluster 1 in the second year); *restatement and making an outline* (both with cluster 1 in the first-year but with cluster 2 in the second-year); *looking for logical relations and getting the gist* (both with cluster 2 in the first-year but cluster 1 in the second-year); and *reading ahead* (not clustered with other strategies in the first year but with cluster 1 in the second year).

Figure 4.3 shows that by the third year the strategies have been more finely grouped into 3 clusters. To make comparisons of the clusters of strategies across the 3 years a little easier, Table 4.2 presents the information from the 3 dendrograms in a more transparent form.

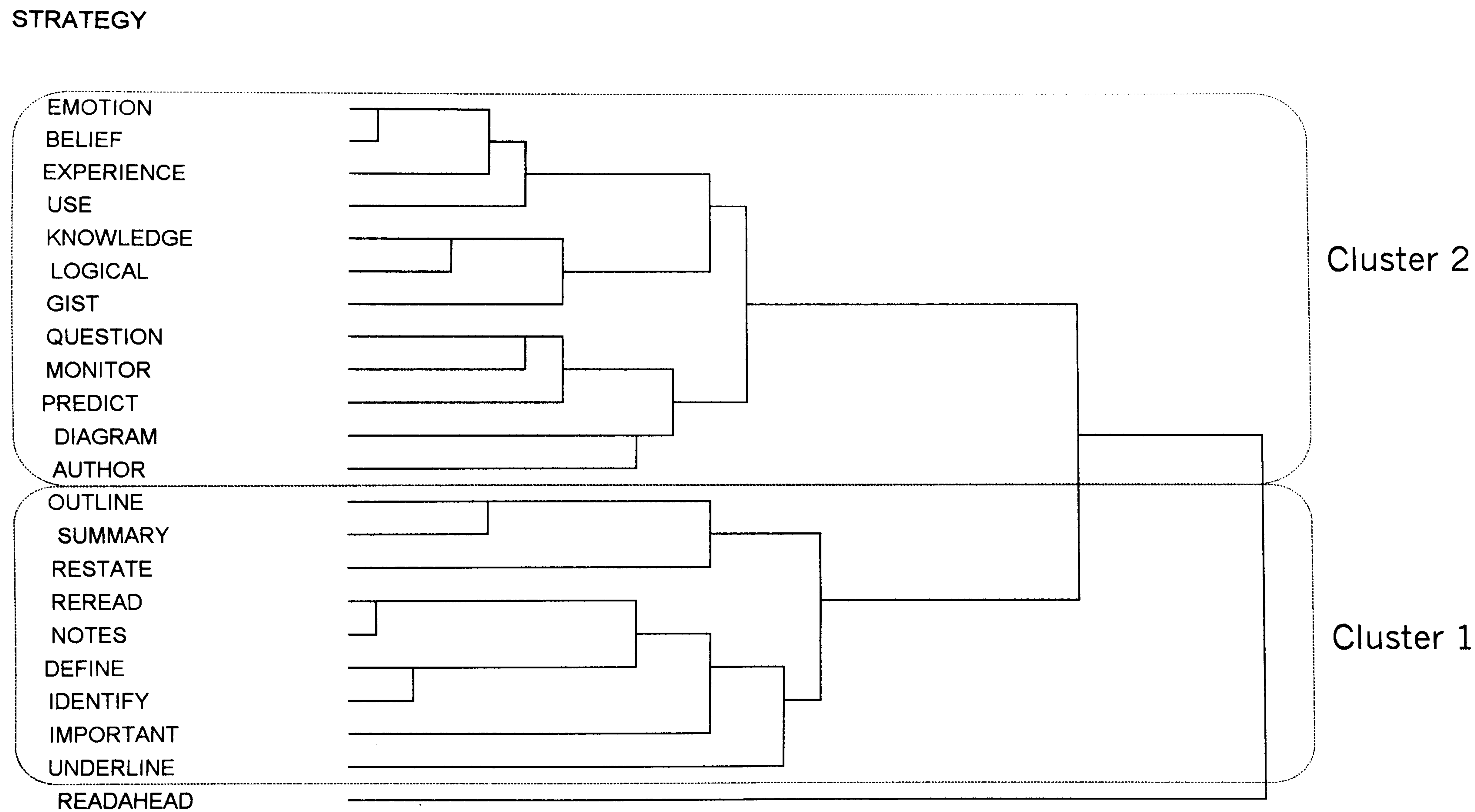


Figure 4.1 Dendrogram of reported ratings of strategy use: Year 1.

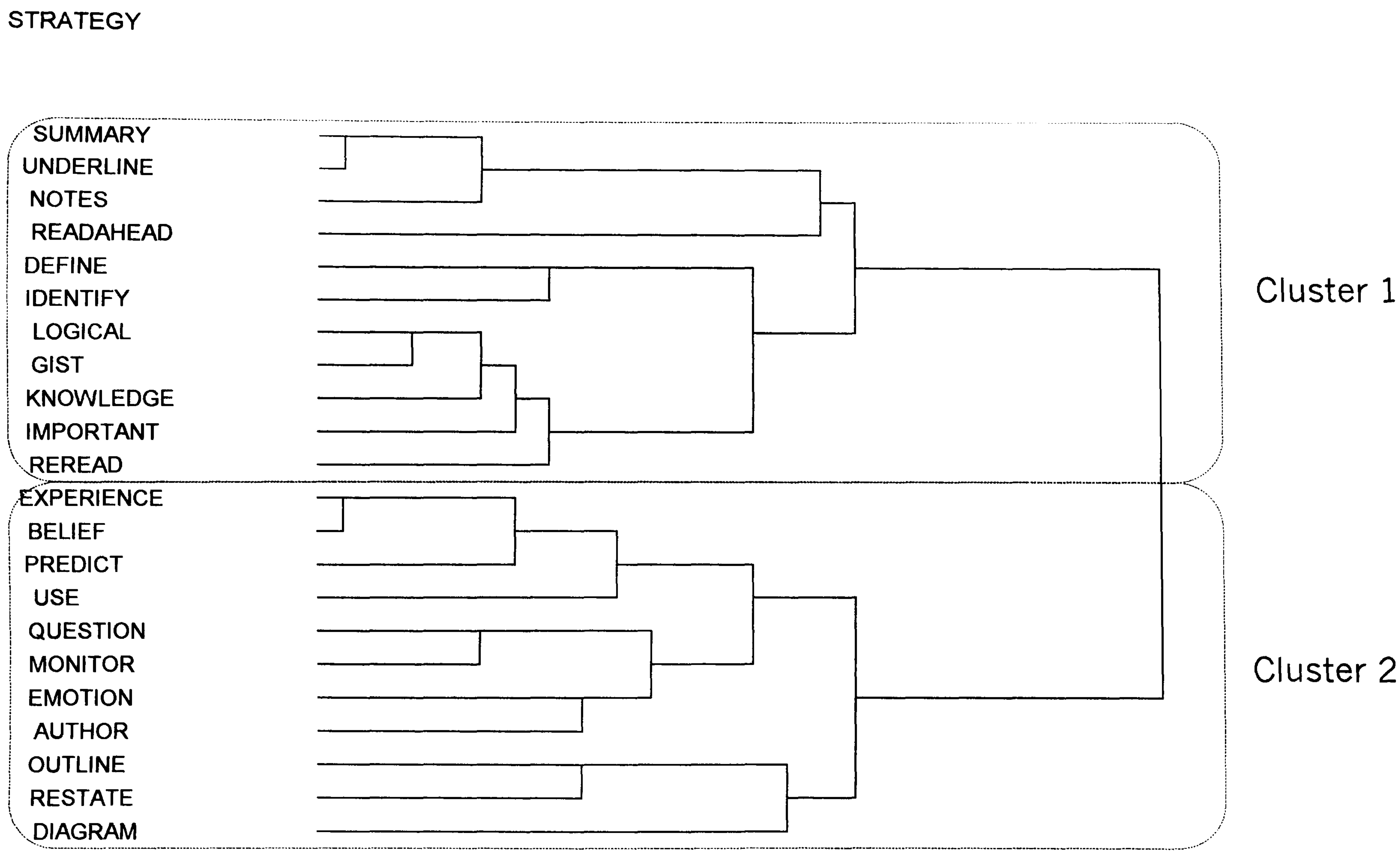


Figure 4.2 Dendrogram of reported ratings of strategy use: Year 2.

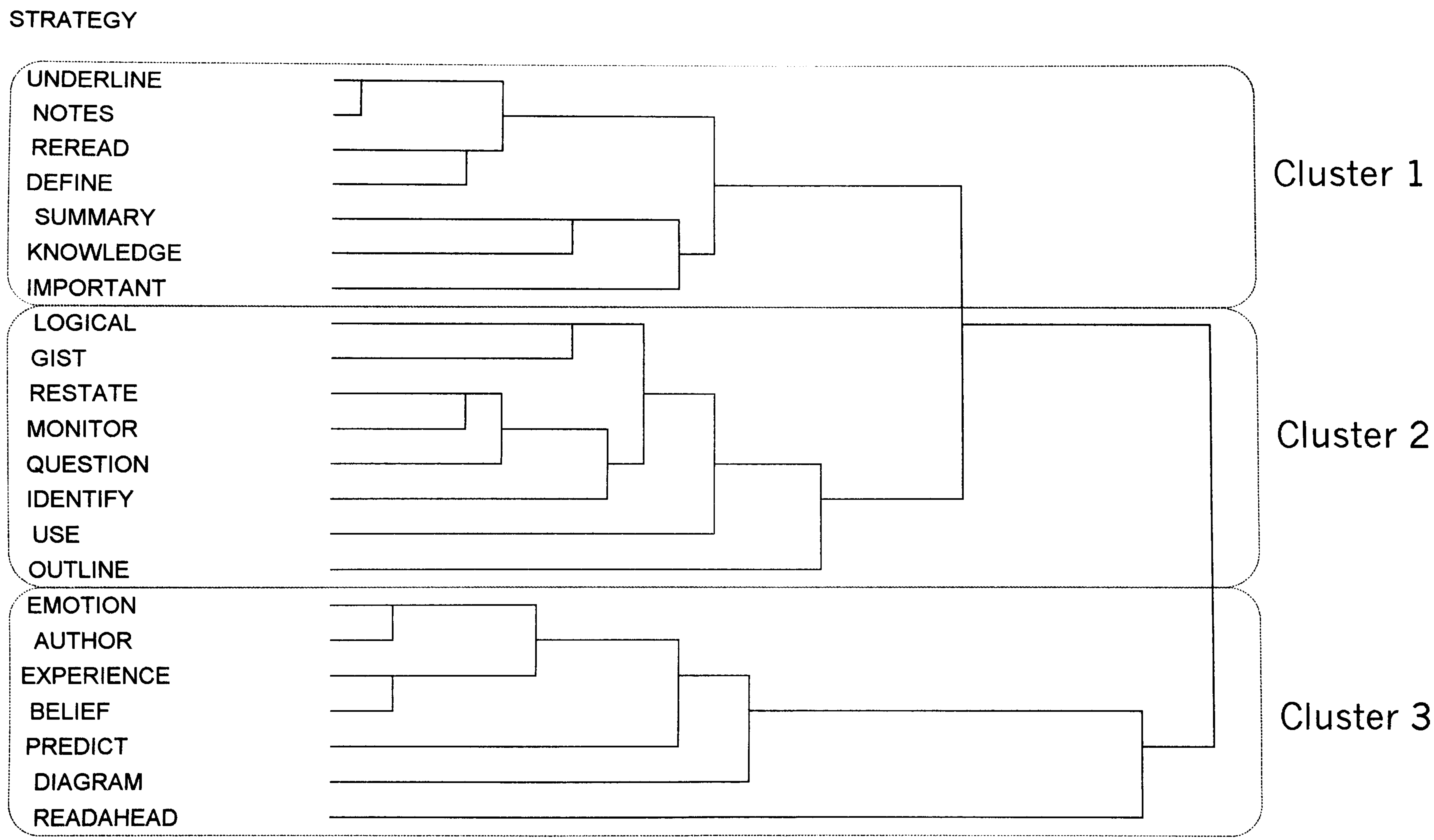


Figure 4.3 Dendrogram of reported ratings of strategy use: Year 3.

strategy	year 1	year 2	year 3
important	cluster 1	cluster 1	cluster 1
underline	cluster 1	cluster 1	cluster 1
define	cluster 1	cluster 1	cluster 1
summary	cluster 1	cluster 1	cluster 1
re-read	cluster 1	cluster 1	cluster 1
notes	cluster 1	cluster 1	cluster 1
knowledge *	cluster 2	cluster 1	cluster 1
identify	cluster 1	cluster 1	cluster 2
restate	cluster 1	cluster 2	cluster 2
outline	cluster 1	cluster 2	cluster 2
logic *	cluster 2	cluster 1	cluster 2
gist *	cluster 2	cluster 1	cluster 2
monitor	cluster 2	cluster 2	cluster 2
use	cluster 2	cluster 2	cluster 2
question	cluster 2	cluster 2	cluster 2
emotion	cluster 2	cluster 2	cluster 3
belief	cluster 2	cluster 2	cluster 3
experience	cluster 2	cluster 2	cluster 3
predict	cluster 2	cluster 2	cluster 3
diagram	cluster 2	cluster 2	cluster 3
author	cluster 2	cluster 2	cluster 3
read ahead *	not clustered	cluster 1	cluster 3

* strategies with discordant clustering

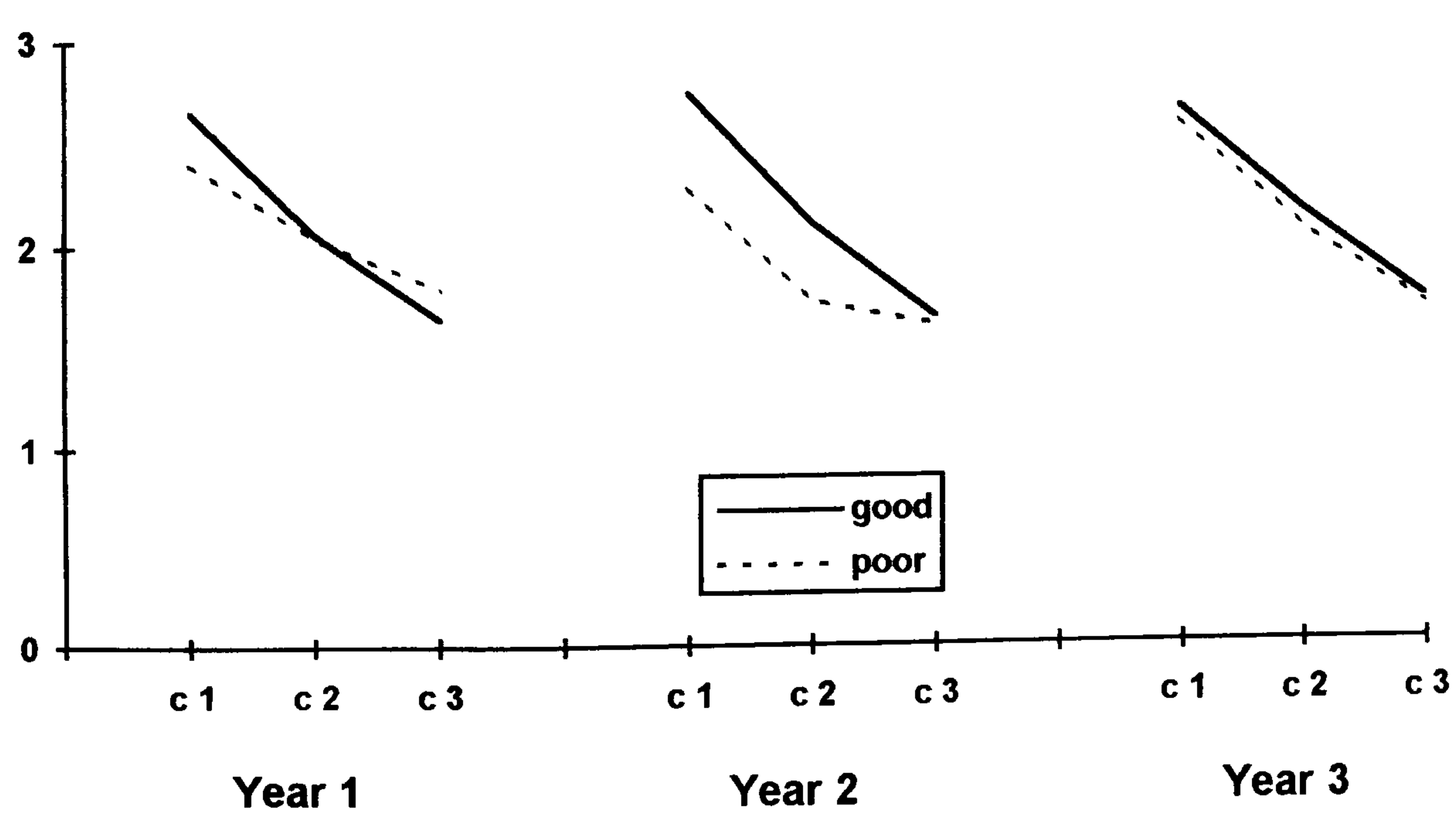
Table 4.1 Clustering of reading strategies in the first, second and third years.

Table 4.1 clearly shows the emergence of 2 clusters from the first and second year ratings; and then these 2 clusters being more finely categorised into 3 clusters by the third year. Some strategies are consistently linked with the same cluster across all 3 years. For example, 6 strategies are consistently linked to cluster 1 in all 3 years; identifying important points, underlining, defining unfamiliar terms, summarising, re-reading, and taking notes. Some strategies show a gradual movement from cluster 1 to cluster 2 strategies, or from cluster 2 to cluster 3 strategies. This probably reflects the modification of 2 clusters being more finely categorised into 3 clusters across the three years. For example, 6 strategies were linked to cluster 2 in the first and second years, then linked to cluster 3 in the third year: linking text to emotions, to beliefs and to experiences; challenging the author; predicting future content; and drawing diagrams.

However, 4 strategies show *discordant* clustering because these strategies were not consistently linked the with same cluster in all 3 years. Furthermore, no gradual movement from cluster 1 to cluster 2, or from cluster 2 to cluster 3 was observed which may be anticipated with the gradual emergence of the third cluster by the third year. These strategies are highlighted in Table 4.1 with an asterisk and were: *linking text to prior knowledge* (cluster 2 in year 1, but cluster 1 in years 2 and 3); *looking for logical relations* and *getting the gist* (cluster 2 in years 1 and 3, but cluster 1 in year 2); and *reading ahead* which did not show any consistent pattern of clustering across the 3 years.

In terms of Spring's (1985) distinction between **study** and **comprehension** strategies some similarities can be seen with the clusters emerging in this study. Cluster 1 comprises four study strategies (notes, re-read, underline and summary); two comprehension strategies (identifying important information and linking text to prior knowledge); and one additional strategy (defining unfamiliar terms). I will suggest shortly that these strategies mostly facilitate memorisation rather than understanding. Cluster 2 comprises three study strategies (restate, question, and outline); one comprehension strategy (logical relations); three additional strategies (identifying unfamiliar terms, monitoring, and getting the gist); and one critical reading strategy (using information). I will suggest shortly that these strategies enhance understanding. Cluster 3 contains three critical reading strategies (linking text to emotions, to beliefs, and to experience); two additional strategies (predicting text content and challenging the author); and the study strategy of drawing diagrams. I will suggest shortly that these strategies require critical thinking.

4.5 Analysis of 3 clusters as a function of learning ability and year of study Analysis was carried out without the discordant strategies shown in Table 4.1. The mean ratings for good and poor learners is shown in Figure 4.4 and the outcomes of the analysis is shown in Table 4.2. ANOVA tables of these mean scores, together with tables of all other measures are given in the appendix, table A4.1 - A4.7



Code: **c1** cluster 1; **c2** cluster 2; **c3** cluster 3.

Figure 4.4 Mean reported frequency ratings of reading strategies for good and poor learners: with all 3 clusters.

Analysis was first carried out on the 3 emerging clusters. Table 4.2 shows no significant effect of group (good vs. poor learners) was found, but two interactions with group were apparent.

source of v ariation	df	F	p
Analysis of 3 clusters			
group	1,23	1.21	ns
type of cluster	2,46	100.46	.000
year	2,46	3.81	.029
group x year	2,46	4.14	.022
group x type of cluster	2,46	2.64	.082

Table 4.2 Outcomes of analyses on clusters of reading strategies.

A group x year of study (year 1 vs. year 2 vs. year 3) interaction is shown in Figure 4.5.

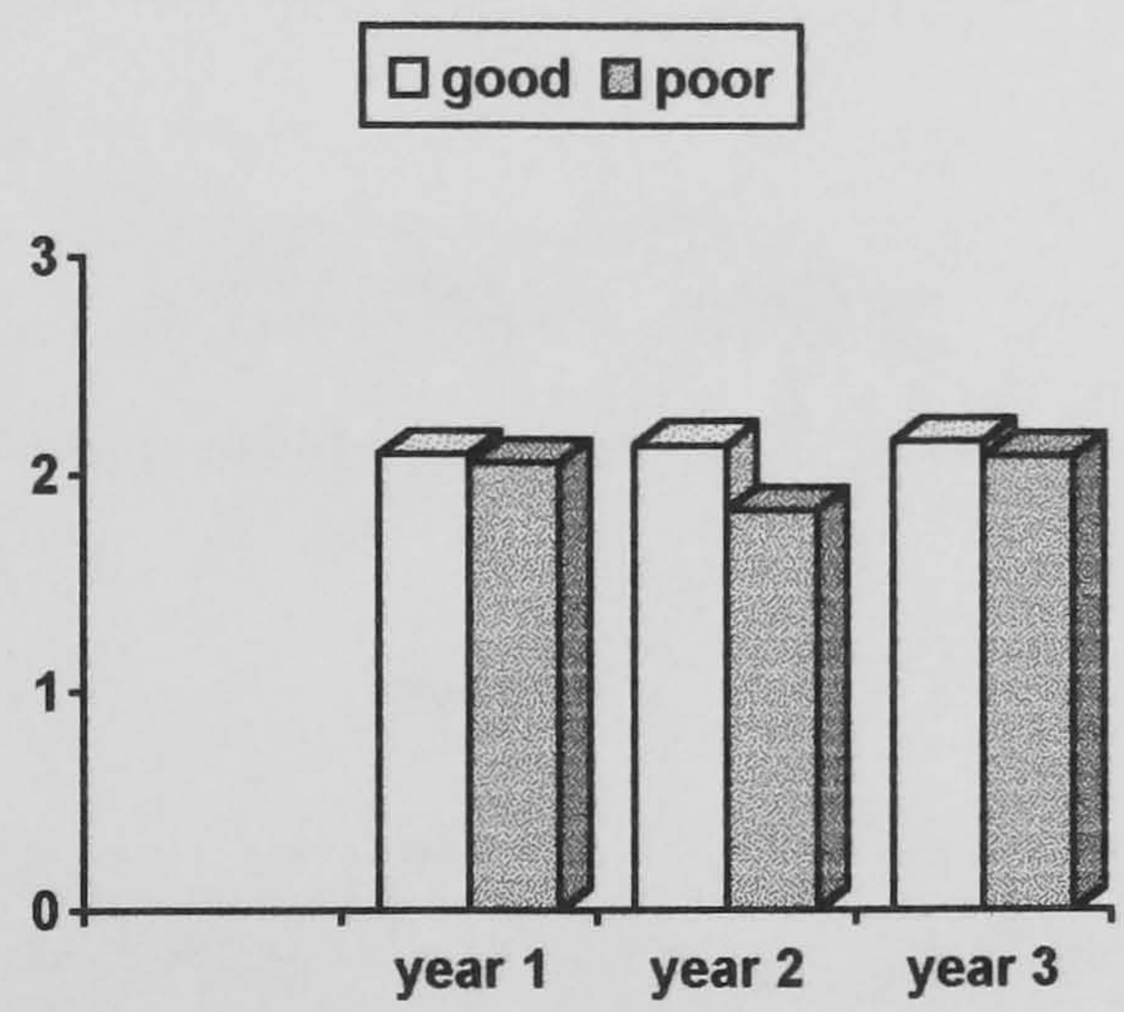


Figure 4.5 Group x year interaction: for all 3 clusters.

Figure 4.5 shows the group x year interaction arises because good learners' ratings increased with experience while poor learners' ratings were lowest in year 2. A marginal group x type of cluster interaction is shown in Figure 4.6.

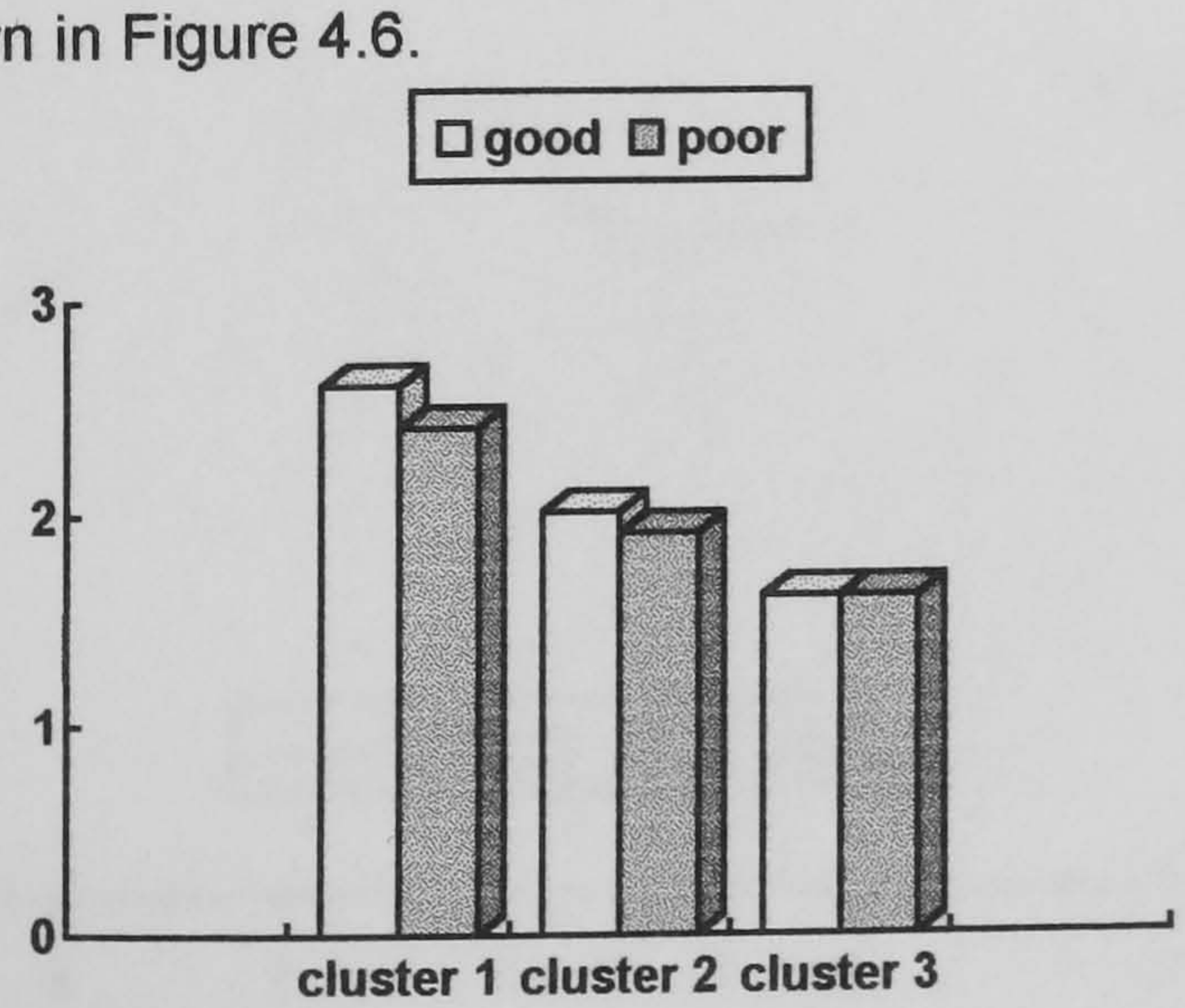
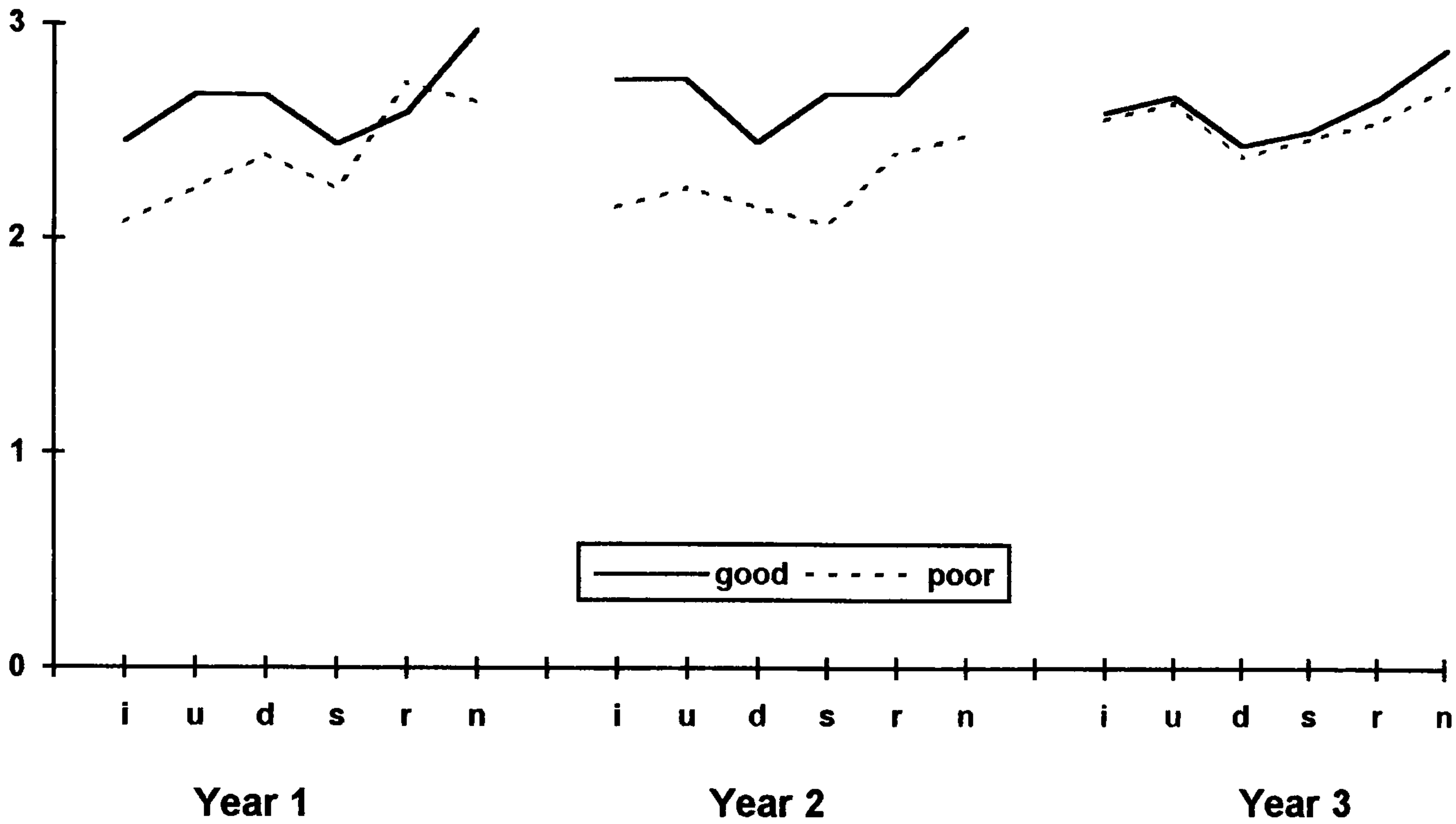


Figure 4.6 Group by type of cluster interaction: with all 3 clusters

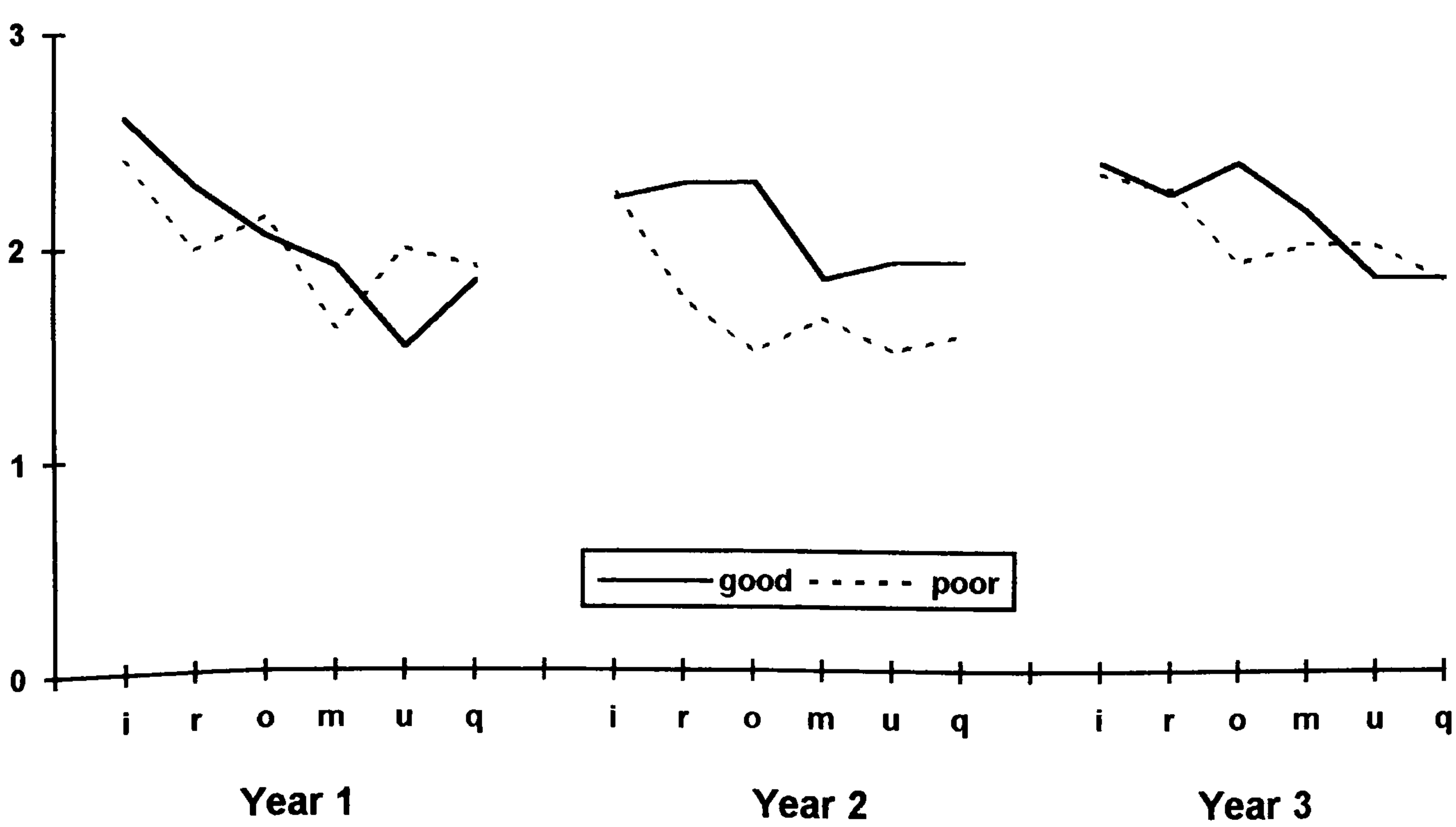
The group x type of cluster interaction shown in Figure 4.6 arises because good learners tended to rate cluster 1 and cluster 2 strategies higher than poor learners. In contrast, both groups tended to rate cluster 3 strategies less frequently. Finally a significant difference between the 3 clusters was found; the strategies in cluster 1 (mean 2.5) were rated higher than those in cluster 2 (mean 2.0) or cluster 3 (mean 1.6).

4.6 Analysis of individual strategies Analysis of the individual strategies was then undertaken by analysing each cluster separately. The individual strategies are shown in Figures 4.7 (cluster 1); 4.8 (cluster 2) and 4.9 (cluster 3).



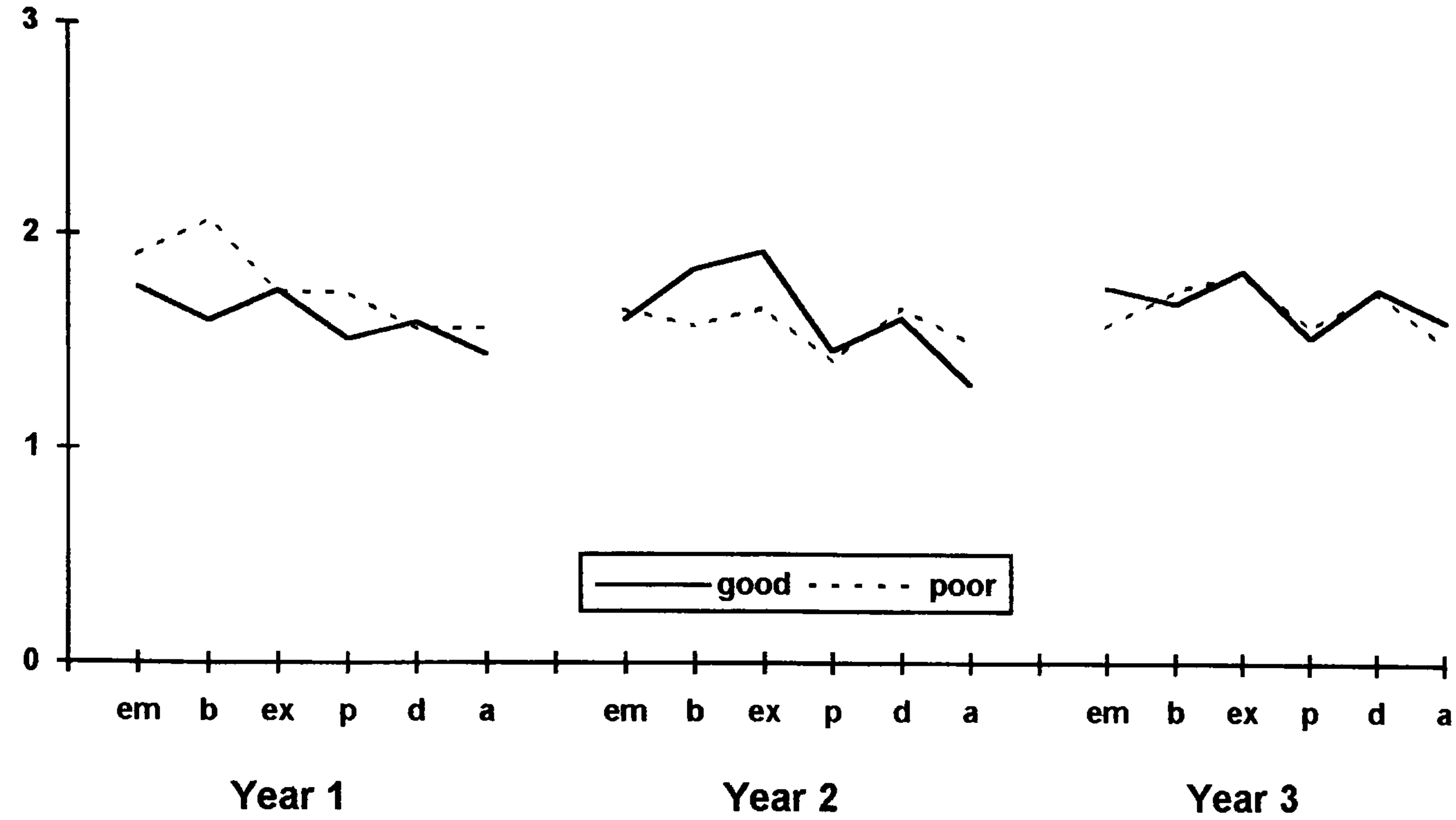
Code: **i** important points; **u** underline; **d** define ; **s** summary; **r** re-read; **n** notes

Figure 4.7 Mean reported frequency ratings of individual strategies for good and poor learners: cluster 1.



Code: **i** identify; **r** restate; **o** outline; **m** monitor; **u** use information; **q** question

Figure 4.8 Mean reported frequency ratings of individual strategies for good and poor learners: cluster 2.



Code: **em** link to emotion; **b** link to beliefs; **ex** link to experiences; **p** predict text; **d** draw diagrams; **a** challenge author

Figure 4.9 Mean reported frequency ratings of individual strategies for good and poor learners: cluster 3.

The outcomes of analysis on the individual strategies are shown in Table 4.3

source of variation	df	F	p
Strategies in cluster 1			
group	1,23	4.01	.05
year	2,46	1.60	ns
type of strategy	5,115	3.94	.002
group x year	2,46	3.96	.026
group x year x type of strategy	10,230	0.62	ns
Strategies in cluster 2			
group	1,22	1.16	ns
year	2,44	3.50	.039
type of strategy	5,110	7.37	.000
Strategies in cluster 3			
group	1,23	.02	ns
type of strategy	5,115	2.39	.042
Analysis of reading ahead			
group	1,22	1.15	ns
year	2,44	1.65	ns

Table 4.3 Outcomes of analysis on individual strategies.

Analysis of individual strategies: cluster 1 Table 4.3 shows that analysis of the individual strategies in cluster 1 revealed a significant effect of group; good learners (mean 2.7) rated these strategies higher than poor learners (mean 2.4). Group also interacted with the year of study. This interaction is shown in Figure 4.10.

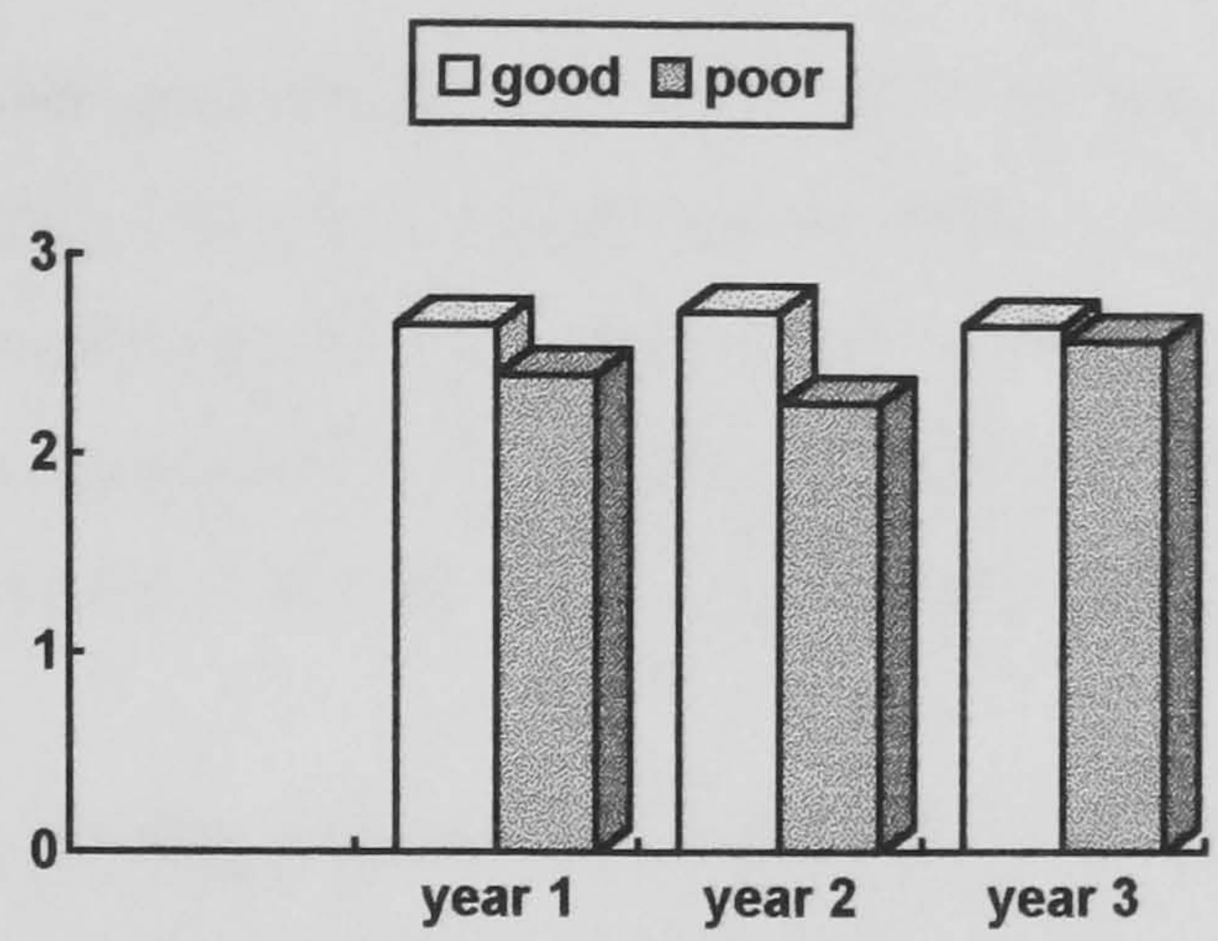


Figure 4.10 Group x year interaction with individual strategies: cluster 1.

The interaction in Figure 4.10 arises because good learners ratings' were highest in year 2 while poor learners ratings were lowest in year 2. A significant difference between the strategies in cluster 1 was also found: taking notes (mean 2.8) had the highest ratings followed in descending order by re-reading (2.6), underlining (2.5), identifying important information (2.4), defining unfamiliar terms (2.4) and summarising (2.4).

Analysis of individual strategies: cluster 2 Table 4.2 shows that analysis of the individual strategies in cluster 2 found no difference between the 2 groups, but group did interact with the year of study. This interaction is shown in Figure 4.11.

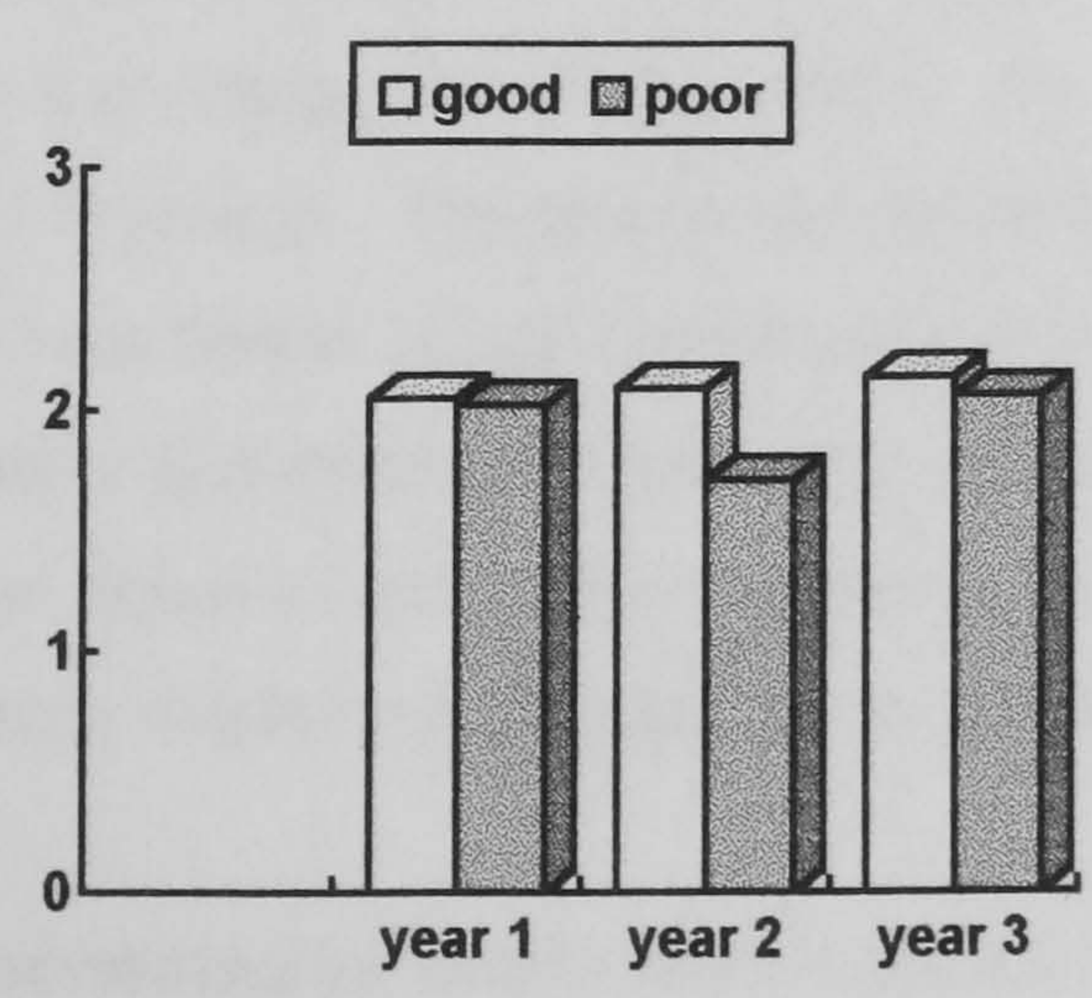


Figure 4.11 Group x year of study interaction with individual strategies: cluster 2.

Figures 4.11 shows the interaction arises because good learners ratings increased with study experience while poor learners ratings were lowest in year 2. Again a significant difference between the individual strategies in cluster 2 was found; identifying unfamiliar terms had the highest rating (mean = 2.3) followed in descending order by restatement (2.1), outlining (2.0), monitoring comprehension (1.8), asking questions (1.8) and using the information in another context (1.8).

Analysis of individual strategies: cluster 3 Table 4.2 shows that the analysis of the individual strategies in cluster 3 found a significant difference between the strategies; linking text to experiences had the highest ratings (mean 1.8) followed in descending order by linking text to beliefs (1.7) and to emotions (1.7), drawing diagrams (1.6), predicting future content (1.5), and challenging the author (1.4). No further effects of interactions were found.

Finally Table 4.1 shows the strategy of reading ahead was not consistently clustered with any of the strategies; and Table 4.3 shows no significant effects of interactions were found.

Discussion

When discussing the findings for reported strategy use I will firstly summarise the results on the use of the 3 clusters as a function of learning ability (i.e. good vs. poor learners) and as a function of study experience (i.e. year 1 vs. year 2 vs. year 3). I will then consider how the individual strategies within each cluster might be characterised as high-level or low-level strategies; and summarise the results on the use of these strategies as a function of learning ability and study experience.

4.7 Reported use of the 3 clusters Three clusters of strategies emerged from students' reports of strategy use. No main effect of **learning ability** (i.e. good vs. poor learners) was found. However, learning ability interacted with **study experience** (year 1 vs. year 2 vs. year 3) as good learners' frequency ratings increased across the 3 years while poor learners' frequency ratings were lowest in year 2. The interaction between **learning ability** and **type of cluster** (cluster 1 vs. cluster 2 vs. cluster 3) just missed significance as good learners tended to have higher ratings with cluster 1 and cluster 2 while both groups tended to have lower ratings with cluster 3. To understand these effects and interactions more clearly, a discussion of how the strategies within each cluster might be characterised is needed.

4.8 The characterisation of strategies within each cluster: Cluster 1 The strategies linked in cluster 1 were underlining, summarising, re-reading, taking notes, defining unfamiliar terms, and identifying important information. *Underlining*, *re-reading* and *taking notes* are generally accepted as low-level memorisation strategies (Spring, 1986; Pressley & Afflerbach, 1995; Weinstein, 1987). These strategies are characterised by an emphasis on memorisation and repetition which facilitate verbatim recall rather than understanding. The benefits of *summarisation* are less clearly defined. Spring and Pressley & Afflerbach describe summarisation as a remembering strategy; others describe it as an elaborative strategy because it can help organise new material effectively (Weinstein, 1987) or because it can help to personalise new material (Schmeck, 1977). In truth writing summaries can facilitate memorisation or understanding depending on the goal of the reader. For example, a text can be adequately summarised by merely reproducing the most active propositions from memory, but this would lead to a superficial understanding (Kintsch, 1994). Alternatively a summary could be used to add symbolic construction to the to-be-learned material in an effort to make it more meaningful. This could help students incorporate the new information into their knowledge base in a more organised fashion (Weinstein, 1987).

Identifying important information involves an active search for meaning enhancing relationships: "*propositions acquire their relative importance not from their physical locations within the paragraphs, but from their meaning relationships with other propositions in the text and with the reader's prior knowledge*" (Spring; 1985, p165). Thus, like summarising, identifying important points could be achieved by accessing the most active propositions from memory, and like summarising, this could lead to a superficial understanding.

The final strategy linked in cluster 1 was *defining unfamiliar terms or phrases*. When an unknown term or phrase is encountered readers can try to determine the meaning by using clues from the surrounding context, or read ahead to try and find clues, or re-read the text with the unknown word. Trying to determine the meaning of words not understood or recognised may enhance understanding. However, "*not understanding the meaning of a word or phrase is not particularly consequential compared to not understanding the text as a whole which occurs more often and is monitored*" (Pressley & Afflerbach, 1995, pp 71).

Analysis of the **3 clusters** found that both groups' ratings were highest for cluster 1 than clusters 2 or 3. Analysis of the **individual strategies** in cluster 1 found a main effect of learning ability; good learners reported using these strategies more often than poor learners, although good learners reported a decreased use in year 3 (year 2 > year 1 = year 3) while poor learners reported an increased use in year 3 (year 3 > year 1 > year 2).

4.9 The characterisation of strategies within each cluster: Cluster 2 The strategies linked in cluster 2 were identifying unfamiliar terms, monitoring comprehension, outlining the text, asking questions, identifying possible uses for the material and restatement. *Monitoring comprehension* is generally accepted as a high-level strategy characteristic of more able readers (Glenberg & Epstein, 1985); although good readers don't always monitor comprehension consistently (Pressley & Ghatala, 1990). *Identifying an unfamiliar term* is similar to monitoring comprehension in that the reader is aware of something unusual or unfamiliar, although failure to understand a word is less problematic than failure to understand the whole text. However, both strategies will enhance understanding rather than memorisation. *Identifying possible uses for the material* is also recognised as a high-level critical reading strategy (Spring, 1985) as it is concerned with the reader's subjective reaction to the text.

The benefits of the remaining strategies in cluster 2 - *asking questions, restatement and outlining the text* - are less clearly defined. To Spring, these are all rehearsal strategies for remembering material. To Weinstein (1987) restatement is an elaborative strategy as it attempts to make the material more meaningful; while outlining the text is an organization strategy as it helps to transform the material into a different format that facilitates understanding. However, the benefits of both restatement and outlining arise from the active cognitive processes of transformation and imposing structure. Asking questions is a strategy used to remember text according to Spring and to Pressley & Afflerbach. But asking questions can resemble the strategy of "setting watchers" (Bereiter & Bird, 1985) where readers flag something as unclear or contradictory and readers set themselves the task of looking for specific information to answer the question. Of course, the reader may not find this information, in which case the query will not be cleared up.

Analysis of the **3 clusters** found that ratings for cluster 2 were higher than the ratings for cluster 3, but lower than the ratings for cluster 1. Analysis of the **individual strategies** in cluster 2 found that good learners' reported use increased over the three years of study (year 3 > year 2 > year 1) but poor learners' reported use was lowest in year 2 (year 3 > year 1 > year 2).

4.10 The characterisation of strategies within each cluster: Cluster 3 The strategies linked in cluster 3 were: linking text to emotions, to beliefs and to experiences; predicting future content; drawing diagrams; and challenging or considering the author. *Linking the content of a text to your beliefs, to your experiences and to your emotions* were categorised as Spring (1985) as high level critical reading strategies; while *challenging the author and predicting what will happen in the text* were defined as high level critical thinking strategies by Fitzpatrick (1994) as they are all concerned with critical thinking and the readers' subjective reaction to the text. Critical thinking is defined as a process for determining the value of an idea, a concept, a solution, or information (Freiberg & Driscoll, 1992); and a process which is associated with inquiry and decision making (Raths, 1986). According to Fitzpatrick "*critical thinking is not encouraged or expected in many classrooms today, yet, the reading comprehension skills of students at all grade levels would improve significantly if teachers focus on specific strategies which require students to think critically.*" (1994, p 142). Fitzpatrick outlined various teaching techniques which require critical thinking. For example, software programs have been developed which require comprehension and critical thinking skills. Co-operative learning tasks can be used as group discussion and social interaction following reading can increase reading comprehension and critical thinking. Also higher order questioning which requires critical thinking can be used by asking students to predict what will happen in a text; asking questions that require implied but not explicitly stated answers; and asking students to evaluate what they read.

The final strategy linked to cluster 3 was drawing diagrams. Although defined as a rehearsal strategy by Spring (1985), some diagrams such as flow charts and mind maps require a degree of critical thinking to determine the relationships between concepts in the text and to represent these relationships in the form of a structured diagram. Drawing diagrams, predicting content and challenging the author had the lowest ratings of all the strategies.

Analysis of the **3 clusters** found that ratings for cluster 3 were lower than the ratings for either cluster 1 or cluster 2. Analysis of the **individual strategies** in cluster 3 found no differences either in terms of learning ability or in terms of study experience. It seems that both groups reported using these strategies infrequently, and the use of these strategies did not increase with study experience.

The strategy of reading ahead showed no consistent pattern of clustering over the 3 years. However, this may be due to the imprecise wording of the item which stated "Hope that something difficult will become clear later". I suspect that students interpreted this to mean passively waiting for the author to clarity the difficulty and were probably confused by the item.

Taken together, the evidence for good learners suggests that they increased their use of high-level understanding strategies (i.e. cluster 2) as they became more experienced; and decreased their use of low-level memorisation strategies (i.e. cluster 1) in their final year. However, good learners did not show signs of developing critical thinking strategies (i.e. cluster 3) as they became more experienced. In contrast, poor learners use of understanding and memorisation strategies reduced considerably in the second year. Like good learners, poor learners did not show signs of developing critical thinking skills as they became more experienced.

Just why poor learners reported using fewer memorisation and understanding strategies in the second-year is not clear. In the previous chapter reported motivation (from the LASSI ratings) of good and poor learners was found to be lower in the second year. Anecdotal comments from the students suggested this may be due to increasing distractions from outside study or a lack of goal orientation. Perhaps the reduction in motivation affected the poor learners' *perceptions* of their strategy use. In contrast, good learners appear to show the beginnings of a **qualitative change in reported strategy use**; that is, an increase in study experience is accompanied by a decrease in the use of study habits (i.e. low-level memorisation strategies) and an increase in deep approaches to study (i.e. high-level understanding strategies). Recall that the studies in Table 1.2 in the literature review found this qualitative change with **reported** strategy use (Zimmerman et al, 1977; Seni et al, 1978; and Watkins & Hattie, 1981). However, the verbal protocols study in chapter 2 failed to find evidence for a qualitative change in **observed** strategy use. It is important to stress that reported ratings of strategy use reflect perceived use of strategies rather than actual use. At first glance it appears that the students' *perceptions* of the strategies they use do not match the strategies they were *observed* using in the verbal protocols experiment. The next chapter follows up this disparity, and compares reported strategy use (using the findings from this study) with the strategies they actually used in the verbal protocols experiment (evaluated in chapter 2).

The strategies linked in cluster 3 require evaluative skills and appear under-developed - even when the students are nearing the end of their study. It is worrying to find that these strategies were used so infrequently and did not develop as the students became more experienced readers. However it is probably not unexpected given that these strategies may only begin to develop at college or undergraduate level, and then not with every individual (Chall, 1983).

Finally, the reported frequency ratings for 3 reading strategies showed inconsistent clustering, compared to the other reading strategies. *Linking text to prior knowledge* was linked to cluster 2 in the first year, but linked to cluster 1 in the second and third years; while *looking for logical relations* and *getting the gist* was linked to cluster 2 in the first and third years but linked to cluster 1 in the second year. Analysis of linking text to prior knowledge and getting the gist revealed that for good learners, reported use increased across the three years, but reported use for poor learners decreased across the 3 years. So even though these strategies showed less stable clustering over the 3 years, a **perceived** developmental trend seems to emerge for good but not poor learners. However, no similar trend was found with looking with logical relationships as ratings were highest for both groups in year 2.

Spring (1985) classed linking text to prior knowledge as an understanding strategy while Weinstein (1987) classed it an elaborative strategy because it creates bridges between a student's prior knowledge and what they are trying to understand. In contrast, Stevenson & Palmer (1994) stress that if the new information is only superficially integrated with prior knowledge understanding will be shallow. For understanding to occur prior knowledge should be used to assess understanding of the new material; and prior knowledge itself should be updated and revised in light of the new material. Relating different parts of the text to get the gist of material can enhance understanding in several ways. Pressley & Afflerbach (1995) give the following examples: understanding of a concept can become clearer as it is developed in different parts of the text; examples can be related to different parts of the text; consistencies and inconsistencies can be identified across different parts of the text; and a point can be reviewed when subsequent text makes this point clearer or the point may assume more importance. Relating different parts of the text can also enable the reader to construct situation models where the information in the text is elaborated and linked with prior knowledge. A deeper understanding is developed from this process of elaborating and integrating the text with prior knowledge (Kintsch, 1988, 1992). The construction of representations during reading is investigated further in chapter 6.

Looking for logical relations within a text can also enhance understanding because it helps to make clear meaning-enhancing relationships. Spring cites evidence from Bransford, Stein, Vye, Franks, Auble, Mezynski, & Perfetto (1982) to support this claim: good readers had better comprehension than poor readers when meaning-enhancing relationships were not explicitly stated. In contrast, both groups performed similarly when these relationships were made explicit. Thus, identifying logical relations to make meaning-enhancing relationships explicit reduces the need for prior knowledge.

In summary, the findings suggest that the strategies linked in cluster 1 do not appear to fit neatly into a memorisation (low-level) or an understanding (high-level) category. Underlining, re-reading, and taking notes are generally accepted as memorisation strategies. In contrast, summarising, identifying important information and defining unfamiliar terms can enhance understanding; but they are all dependent upon interaction between the readers' knowledge base, the characteristics of the text, and the representation constructed while reading. Consequently, if new information is only superficially integrated with prior knowledge, understanding will be superficial. The strategies linked in cluster 2 are high-level strategies which can enhance understanding. Monitoring, identifying unfamiliar terms and asking questions help the reader to monitor their understanding and make the reader aware of any comprehension problems. Restatement and making an outline help the reader to impose structure and transform the material into a more meaningful form, and these processes of transformation and imposing structure enhance understanding. Finally, thinking of possible uses for the material reflects an evaluative judgement on the part of the reader and engages the reader to react to the text. The strategies linked in cluster 3 require critical thinking skills as the readers evaluate the text in light of their own experiences and beliefs, and react with the text in a subjective manner. These skills are often neglected in the learning process and more recently researchers such as Fitzpatrick (1994) have stressed the need to teach students to think critically.

CHAPTER 5

Reported versus Observed Strategy Use

5.1 Aims of this study The aim of this chapter is to establish whether students actually use the strategies they say they use. In section 1.7 of the literature review, evidence for the consistency between reported and observed strategy use was shown to be equivocal. Cavanaugh & Borkowski (1980) found that explicit metacognitive knowledge of strategies did not distinguish children who used strategies from children who did not; and that a good verbalizable memory was not related to performance on memory tasks. In contrast, Waters (1982) found a relationship between metamemory and performance, since adolescents who knew that elaboration was better than non-elaborative strategies were more successful at recalling word pairs. Evidence from studies of university students is also unclear. Phifer & Glover (1982) found that college students did not consistently use the metacognitive strategies they reported using. In contrast, Alexander (1986) found that university students who said they used the underlining strategy applied this strategy when reading.

It appears that students seem to have some surface understanding of the strategies they think they should be using, but for some reason they don't act on this understanding when observed. My prediction is that consistency between reported and observed strategy use is more likely to be found with low-level strategies such as underlining than with high-level strategies such as monitoring comprehension. This would explain the different findings of Alexander and Phifer & Glover. The justification for this claim is that students are more likely use low-level than high-level reading strategies. For example, students are more likely to have the declarative knowledge that re-reading can overcome comprehension failure (Baker & Anderson, 1982); and have procedural knowledge of how to use the re-reading strategy, such as using key words to identify what needs to be re-read to overcome comprehension failure (Garner, 1990). But with high-level strategies such as monitoring comprehension, students may have the declarative knowledge and know about monitoring, but are unable to monitor comprehension because they don't know how to (i.e. lack the procedural knowledge) or perhaps because too much effort is required.

What is less clear is the possible consistency between reported and observed use with infrequently used strategies such as critical reading strategies. Students may be aware that they do not use these strategies frequently, or they may not be aware of them at all - hence, they report using them infrequently. However, students may also use them infrequently in the reading experiment. If this is so, there will be strong consistency - but of a low frequency. This contrasts the strong consistency - but of a high frequency - expected with the re-reading strategy.

In this study reported strategy use is compared with observed strategy use. Reported strategy use is assessed with the reading strategies questionnaire described in the previous chapter. Observed strategy use is assessed by whether strategies were used when students read texts in the verbal protocols experiment described in chapter 2. **High consistency** between reported and observed strategy use is achieved when students *report* using a strategy frequently (by giving it a rating of 3 in the reading strategies questionnaire); and are also *observed* using that strategy in the verbal protocols experiment. **Low consistency** between reported and observed strategy use is achieved when students report using a strategy frequently but then are not observed using that strategy in the verbal protocols experiment.

The predictions for this study of reported vs. observed strategy use are as follows. First, consistency between reported and observed strategy use of **low-level** strategies (e.g. re-reading) will be **high** as students will report using these strategies frequently and will also be observed using these strategies in the verbal protocols experiment. Second, consistency between reported and observed strategy use of **high-level** strategies (such as monitoring) will be **low** as students will report using these strategies frequently but will then fail to use them in the verbal protocols experiment. Third, consistency between reported and observed strategy use of **critical reading strategies** will be **high** as students will not report using these strategies frequently and will also fail to use them in the verbal protocols experiment.

Method

5.2 Subjects The good and poor learners who took part in the verbal protocols (see chapter 2) experiment and who completed the reading strategies questionnaire (see chapter 4) were included in this study. Thus 13 good and 12 poor learners took part in the study of reported vs. observed strategy use.

Materials No separate materials were required for this study as measures of reported strategy use were assessed with ratings from the reading strategies questionnaire and measures of observed strategy use were assessed from the strategies used in the verbal protocols experiment.

Design and Procedure First, learners who reported using a strategy frequently (i.e. gave a rating of 3 in the reading strategies questionnaire) were identified. Second, learners who reported using a strategy frequently and who subsequently used that strategy in the verbal protocols experiment were identified. The percentage of learners who reported using a strategy frequently was then compared with the percentage of learners who reported using a strategy frequently and who also used that strategy in the verbal protocols experiment.

When comparing reported and observed strategy use, some of the strategies on the reading questionnaire were never used by learners in the verbal protocols experiment. These strategies were taking notes, making an outline, thinking about how the material could be used, and looking for logical relationships. Although the students were provided with pens and paper, none elected to take notes or make an outline. Also, no evidence of thinking about possible uses for the material or of looking for logical relationships was found in the think alouds. Some of the strategies in the verbal protocols experiment were easier than others to categorise such as re-reading, underlining and drawing diagrams because they were readily observed. Other strategies were less straightforward to categorise, but because they were used infrequently they tended to be distinctive and this made the process of categorisation a little easier. These strategies were linking the text to real-life experiences, identifying important points, defining and identifying unusual terms, linking different text segments, reading ahead and comprehension monitoring. Observations of all these strategies used in the verbal protocols experiment will be compared with reported ratings from the reading strategies questionnaire.

However, a small number of strategies were very difficult to categorise in the think aloud experiment because the protocols were often incomplete or not specific; and also because the boundaries between one category and another were not simple and discrete but indistinctive and subjective. Two strategies on the reading strategies questionnaire - restatement (item 4) and relating the material to what I already know (item 9) were very difficult to distinguish in the verbal protocols experiment. The problem of differentiating restatements from inferences was explained in section 2.12 of the verbal protocols experiment. To recap briefly, this task involves determining whether the think aloud protocol reflects purely textual information or reflects some degree of the reader's prior knowledge. When readers put the text into their own words this usually entails substituting one word for another, or making bridging or elaborative inferences, all of which involves some degree of knowledge. I therefore decided to categorise restatements and inferences into a general category called **inferencing**. Observed use of inferencing in the verbal protocols experiment will be compared with reported ratings of item 9 on the reading strategies questionnaire '*relate the material to what I already know*', and with item 4 '*restate the material in my own words*'. It will be interesting to see if one of these items shows more consistency than the other as this could reflect subtle differences in the learners' metacognitive knowledge of strategies.

Three further strategies were difficult to distinguish in the think aloud experiment and these strategies were also included in the reading strategies questionnaire: challenging the author (item 20); reacting critically to the text (item 15) and relating the text to your own beliefs and attitudes (item 12). In section 2.9 of the verbal protocols experiment learners were shown to challenge the author's views in several different ways: some offered alternative explanations to those of the author; some reacted critically to the text but failed to provide alternative explanations; and others expressed their own beliefs and attitudes which opposed those expressed by the author. Each of these strategies could clearly be seen to challenge the author and reflect critical thinking skills. However, because the protocols were often incomplete or not specific it was difficult to pinpoint whether the reader had an emotional or critical reaction to the text or whether they related the text to their own beliefs and attitudes. Again to avoid the problem of subjectively forming smaller categories these strategies were grouped into a general category called **challenging the author**. Observed challenges to the author in the verbal protocols experiment will be compared with reported ratings of item 20 on the reading strategies questionnaire; *think of different explanations to challenge the author's view*; with *reacting critically to the text* (item 15) and with *relating the material to your beliefs and attitudes* (item 12). Consistency between reported and observed strategy use with these critical thinking strategies is expected to be high, with learners reporting infrequent use of these strategies and also failing to use them in the verbal protocols experiment.

One final group of strategies were difficult to distinguish in the verbal protocols experiment and they all concerned questioning the text. Section 2.9 of the verbal protocols experiment shows that most learners asked questions to test their understanding. This strategy was included in the reading strategies questionnaire as item 3. A smaller number of learners questioned the text by setting watchers, defined by Bereiter & Bird (1985) as "*a response to missing information that the reader expected later portions of text to supply*". Most instances of setting watchers in the verbal protocols experiment took the form of making predictions about what the text will say next, or say shortly. This strategy was also included in the reading strategies questionnaire as item 21. Another type of questioning the text resembled Bereiter & Bird's description of asking questions; that is, "*expressing dissatisfaction with the present state of information*". Bereiter & Bird distinguish watchers from questions as the former express *anticipation* while the latter express *dissatisfaction*. In section 2.9 of the verbal protocols experiment examples were given which illustrated these types of questions as well as the problems of defining concepts such as anticipation and dissatisfaction. Therefore, a general category of **asking questions** was used in the verbal protocols experiment. Observed instances of asking questions from the verbal protocols will be compared with reported ratings of item 3 on the reading strategies questionnaire '*ask myself questions to test my understanding of the material*'; and with item 21 "*make predictions about what may come later in the text.*" As both strategies are concerned with self-questioning I would expect similar levels of consistency between reported and observed strategy use.

Finally, two strategies observed in the verbal protocols experiment were not included in the reading strategies questionnaire; taking the text in and recalling prior learning situations. Taking the text in appeared very similar to the **crunching** strategy first identified by Johnson & Afflerbach (1985) who described the procedure as "stopping input rather than passively waiting for an automatic process to operate on information already in working memory". In this study several learners stopped reading and said they were "trying to take the text in" which resembled this active process of "crunching" down the information in working memory. However, the percentage of learners using this strategy when reading was low, ranging from 0% to 13% depending on the year of study and familiarity of the text. Recalling prior learning was observed more frequently in the verbal protocols experiment and involved learners stating where they had first come across the topic of the text. For example, "*I remember this from my A level exams.*" Use of this strategy in the verbal protocols experiment increased with experience, which is not surprising as the learners are more likely to have encountered the topic of the text. However it did not enhance understanding as the learners were merely commenting that the topic of the text (but not the content) was familiar to them. The percentage of learners using this strategy when reading ranged from 0% to 47% depending on the year of study and familiarity of the text. Neither of these strategies were anticipated when the reading strategies questionnaire was devised, therefore reported use cannot be compared with observed use.

Results

5.3 Comparisons The percentage of learners who **reported** using a strategy frequently are compared with the percentage of student who reported using a strategy frequently and who also were **observed** using that strategy in the verbal protocols experiment. Initially these percentages are averaged across 3 years of study to gain an overall picture. These data are shown in Table 5.1. Following this the percentages are presented for each year of study: the data for year 1, year 2 and year 3 are shown in Tables 5.2, 5.3 and 5.4 respectively.

In all these tables the data for good learners is shown on the left hand panel of the table while the data for poor learners is shown in the right hand panel. The strategies are grouped according to the clusters identified in chapter 4: the memorisation strategies in cluster 1 are shown first; the understanding strategies in cluster 2 are shown next; and the critical thinking strategies in cluster 3 are shown last.

5.4 Cluster 1: memorisation strategies A high level of consistency between reported and observed strategy use of memorisation strategies was found only with the **re-reading** strategy, and then only with the **good learners**. 67% of good learners said they used the re-reading strategy and 56% were observed to do so. In contrast, 61% of poor learners reported re-reading frequently but only 33% were observed re-reading. Some consistency was also found with inferencing: 36% - 39% of good learners said they used restatement or used prior knowledge when reading and 35% did actually use these strategies when reading. Less consistency was found with poor learners: 25% said they used restatement frequently and 50% said they used their prior knowledge when reading. However only 22% were observed using these strategies when reading.

	good learners		poor learners	
	frequently reported strategies %	frequently reported & observed strategies %	frequently reported strategies %	frequently reported & observed strategies %
Cluster 1 memorization strategies				
take notes (5)	*97*	0	*72*	0
underline (2)	*82*	12	*56*	8
important points (11)	*67*	8	*44*	5
re-read (1)	*67*	56	*61*	33
summary (7)	*59*	0	*41*	0
define unfamiliar terms (16)	*59*	3	*42*	5
inferencing (observed in experiment) compared to:				
restatement (4)	*36*	35	*25*	22
relating text to knowledge (9)	*39*	35	*50*	22
Cluster 2 understanding strategies				
identify unfamiliar terms (17)	*51*	18	*39*	22
outline (6)	*44*	0	*22*	0
logic (10)	*38*	0	*33*	0
link text segments (19)	*33*	8	*31*	0
monitoring (18)	*20*	20	*14*	13
use information in text (13)	*13*	0	*19*	0
questioning (observed in experiment) compared to:				
asking questions (3)	*13*	5	*17*	10
predict text content (21)	*3*	5	*6*	10
Cluster 3 critical thinking strategies				
real life experiences (14)	*13*	3	*11*	3
draw diagram (8)	*13*	5	*14*	0
challenging the author (observed in experiment) compared to:				
challenge the author (20)	*0*	0	*6*	0
emotional reaction (15)	*5*	0	*22*	0
relate to beliefs (12)	*8*	0	*19*	0
Unclustered strategy				
read ahead (22)	*34*	8	*53*	3

number in brackets refers to the number of strategy on the reading strategies questionnaire

Table 5.1 : Percentage of learners who reported using a strategy frequently compared to the percentage of learners who reported using a strategy frequently and who subsequently used that strategy in the verbal protocols experiment.

Consistency between reported and observed use of the other memorisation strategies was low. Table 5.1 shows that no learners took notes or summarised the text in the reading experiment. In contrast 97% of good and 72% of poor learners reported taking notes frequently; and 59% of good and 41% of poor learners reported using summarisation frequently. Self-reports of identifying important points (good 67%; poor 44%) and defining unfamiliar terms (good 59%;

poor 42%) were also disappointingly inconsistent with observed use as hardly any learners used these strategies in the verbal protocols experiment (identifying important point: good 8%, poor 5%; defining unfamiliar terms (good 3%, poor 5%).

5.5 Cluster 2: understanding strategies Consistency between reported and observed use with some of the understanding strategies was low. Between one-third and one-half of good and poor learners reported using the following strategies frequently: identifying unfamiliar terms; outlining the text; looking for logical relations; and linking text segments. However, only 18% of good learners and 22% of poor learners were observed identifying unfamiliar terms; and only 8% of good learners were observed linking text segments. No good or poor learners were observed outlining the text or looking for logical relations; and no poor learners were observed linking text segments. Thus consistency between reported and observed strategy use of these 4 understanding strategies is low.

Consistency with the remaining understanding strategies was high as only a small number of learners said they used these strategies frequently and very few were observed using them. Less than one-quarter of learners reported monitoring comprehension; thinking how to use the information in the text; asking questions or setting watchers. Table 5.1 shows that the learners' perceptions of infrequent monitoring were accurate; while the remaining understanding strategies were infrequently reported and even more infrequently used.

5.6 Cluster 3: critical thinking strategies Consistency between reported and observed use of all of the critical thinking strategies was low for both good and poor learners. Very few learners said they used these strategies frequently, ranging from 0% (good learners reporting challenging the author frequently) to 22% (poor learners reporting reacting emotionally to the text). This perception of infrequent use was matched by a failure to use these strategies when reading. Of the few good and poor learners who said they challenged the author; or reacted emotionally to the text; or related the text to their beliefs - none of them subsequently used these strategies when reading. Furthermore, only a small number of learners said they related the text to their own experiences or drew diagrams frequently, and an even lower number actually used these strategies when reading.

Finally low consistency was found with the strategy of reading ahead; 34% of good and 53% of poor learners said they used this strategy frequently but only 8% of good and 3% of poor learners used this strategy when reading. This strategy did not cluster with any of the other items, and I will suggest in the discussion that the meaning of this strategy was unclear and learners were not sure how to interpret it.

Taken together, the data in Table 5.1 show a disappointing lack of agreement between reported and observed strategy use. The highest level of consistency was found with good learners re-reading the text. While a similar number of poor learners reported re-reading frequently observed use was lower. Some consistency was found with restatement and using prior knowledge, but this was not characteristic of all learners. Only one-third of the good learners reported using these strategies frequently and also used them when observed. All other memorisation strategies were optimistically reported as frequently used but rarely observed. Consistency with the understanding strategies was disappointing. With some understanding strategies perceptions of infrequent use were upheld with infrequent - or even non-existent observed use (e.g. questioning, using, predicting and monitoring material). With other understanding strategies self-reports were inconsistent with observed use as 33% to 51% of learners said they used these strategies often but failed to use them when observed (e.g. identify terms, outline, logic and linking text). With all of the critical thinking strategies, perceptions of infrequent use were upheld with infrequent or non-existent observed use.

The overall picture is one of concern as agreement between self-reports and observed practices is poor with many of the strategies. However, one hope is that perceptions of strategy use may become more accurate as learners become more experienced at using strategies. If this is the case, the expectation is that consistency between reported and observed strategy use would improve with experience. This possibility is now considered. Reported and observed strategy use is compared in the first, second and third years. Reported and observed use of memorisation strategies, understanding strategies and critical thinking strategies is compared in Tables 5.2, 5.3 and 5.4 respectively.

Comparisons in Table 5.2 show very little change in self-reports and observations of memorisation strategies as a function of year of study. The only improvement between perceived and observed use was found with the re-reading strategy, and then only with good learners. With good learners, perceived use was over-estimated in the first year but by the third year reported use matched observed use (i.e. 69%). Agreement was less apparent with poor learners. Self-reports and observations of re-reading were greatest in the first year but lowest in the second year, and perceived use was always greater than observed use. With taking notes and summarising very little change was observed across the 3 years. No good or poor learners used these strategies in the first year, and only a few used them in the second and third years (8% - 23%). With reported use however, most good learners (77% - 100%) and between one-half and two-thirds of the poor learners reported using them often in all 3 years. A similar picture emerged with identifying important ideas and defining unfamiliar terms. At least one-half (first-year) and at most three-quarters (second year) of the good learners reported using these strategies often, but never - or rarely - used them when observed in the first, second and third years.

	good students						poor students					
	year 1		year 2		year 3		year 1		year 2		year 3	
	reported	observed	reported	observed	reported	observed	reported	observed	reported	observed	reported	observed
Cluster 1: memorisation strategies												
take notes (5)	100	0	100	0	92	0	75	0	67	0	75	0
underline (2)	85	0	85	15	77	23	50	0	50	8	67	16
important point (11)	54	8	77	0	69	15	33	16	33	0	67	0
re-read (1)	62	38	69	61	69	69	75	50	42	16	67	33
summary (7)	46	0	69	0	62	0	33	0	33	0	58	0
define terms (16)	69	8	54	0	54	0	50	0	33	8	42	8
inferencing (observed) compared with:												
restatement (4)	38	38	38	38	31	30	25	25	17	16	33	25
relate to knowledge (9)	31	38	31	38	54	30	58	25	58	16	33	25

number in brackets refers to number of strategy on the reading strategies questionnaire

Table 5.2 : Percentage of students who reported using memorisation strategies frequently compared to the percentage of students who were observed using those strategies in the verbal protocols experiment.

	good students						poor students					
	year 1		year 2		year 3		year 1		year 2		year 3	
	reported	observed	reported	observed	reported	observed	reported	observed	reported	observed	reported	observed
Cluster 2: understanding strategies												
identify terms (17)	62	23	46	15	46	15	50	8	33	33	33	25
outline (6)	31	0	46	0	54	0	33	0	8	0	25	0
logic (10)	38	0	23	0	54	0	42	0	33	0	25	0
link text (19)	31	0	46	16	23	8	17	0	50	0	25	0
monitoring (18)	15	15	15	15	31	30	9	8	17	16	17	16
use information (13)	0	0	31	0	8	0	25	0	8	0	25	0
questioning (observed) compared to:												
ask question (3)	15	8	8	0	15	8	25	8	8	16	17	8
predict text (21)	0	8	0	0	8	8	17	8	0	16	0	8

number in brackets next to strategy refers to number of strategy on the reading strategies questionnaire

Table 5.3 : Percentage of students who reported using understanding strategies frequently compared to the percentage of students who were observed using those strategies in the verbal protocols experiment.

	good students						poor students					
	year 1		year 2		year 3		year 1		year 2		year 3	
	reported	observed	reported	observed	reported	observed	reported	observed	reported	observed	reported	observed
Cluster 3: critical thinking strategies												
experiences (14)	15	8	23	0	0	0	8	8	8	0	17	0
diagrams (8)	8	0	15	8	15	8	8	0	17	0	17	0
questioning (observed) compared to:												
challenge author 20	0	0	0	0	0	0	17	0	0	0	0`	0
emotional reaction (15)	15	0	0	0	0	0	33	0	17	0	17	0
link to beliefs (12)	8	0	15	0	0	0	33	0	8	0	17	0

number in brackets next to strategy refers to number of strategy on the reading strategies questionnaire

Table 5.4 : Percentage of students who reported using critical thinking strategies frequently compared to the percentage of students who were observed using those strategies in the verbal protocols experiment.

With inferencing agreement between reported and observed use was consistent across the 3 years with good learners. In their first, second and third years about one-third of the good learners reported using and were observed using these strategies. Of course, the reverse side of this coin is that two-thirds of the good learners said they did not use - or only occasionally used - these strategies and then failed to use them in the verbal protocols experiment in their first, second and third years. In contrast, poor learners tended to over-estimate their use of linking text to prior knowledge. In the first and second year 58% of poor learners said they used this strategy but only 25% (first-year) and 16% (second-year) actually used it when reading. In the final year one-third of the poor learners reported using this strategy while one-quarter actually made inferences when reading. The main point however, is that apart from the re-reading strategy, the majority of good and poor learners reported never using - or infrequently using - the memorisation strategies in cluster 1 and also failed to use them when reading; and that finding was consistent across all 3 years of study.

Comparisons in Table 5.3 show little change in the perceived and observed use of understanding strategies. Using information, asking questions and predicting content were infrequently reported and rarely observed by both groups in all 3 years. Observations of making an outline, looking for logical relations and linking the text were almost non-existent and this contrasted fluctuating self-reported. Good learners' self-reported percentages of making an outline increased from 31% to 54% in the first to the third year while poor learners self-reports fluctuated inconsistently (33%, 8% and 25% in the first, second and third year respectively). Good learners self-reports of looking for logical relations decreased from the first (38%) to the second (23%) year, but then increased in the third year (54%). Poor learners reported use of this strategy decreased from the first (42%) to the second (33%) to the third year (25%).

The only improvement between perceived and observed strategy use can be seen with the monitoring and the identifying unfamiliar terms strategies. With monitoring 15% of good learners reported using this strategy often and also used it when reading in the first and second years, and this consistency rose to 31% for reported and observed use in the third year. With poor learners the same consistency was found but with fewer students (about 10% reported using and also used this strategy when reading in the first year, and this percentage rose to nearly 20% for reported and observed use in the second and third years).

With identifying unfamiliar terms, poor learners over-estimated their use of this strategy in the first year (50% reported use compared with 8% observed use). But by the second year both reported use and observed use had increased to 33%; although observed use dropped off slightly in the final year (25%). Good learners overestimated their use of this strategy in all 3 years.

Comparisons in Table 5.4 show that all of the critical thinking strategies were infrequently reported and rarely observed. Challenging the author, reacting emotionally to the text, and linking the text to beliefs were never observed in the verbal protocols experiment and were also infrequently reported. Linking text to experiences and drawing diagrams were rarely observed and also infrequently reported.

Discussion

A high level of consistency between reported and observed strategy use was only found with good learners and the memorisation strategy of re-reading; most good learners (69%) said they used this strategy frequently and also used it when observed. Learners' perceptions of the remaining strategies range from being overly optimistic (e.g. taking notes) where perceived use is much greater than observed use; to accurately pessimistic (e.g. critical thinking strategies) where perceived use and observed use are equally poor. The overall picture emerging from this chapter is that learners have a preference for re-reading but make little attempt to enhance their understanding; or to think critically about the material they read. These findings support those of Simpson (1984) and Brennan, Winograd, Bridge & Hiebert (1986) who both question the assumption that "college learners have highly developed systems for studying" (Brennan et al, pp 357). Before looking more closely at the findings, it is important to acknowledge the constraints of observing strategy use in an experimental setting. When reading texts in a more naturalistic environment, such as reading for assignments or for exams, the strategies learners use may be very different to the ones observed in the verbal protocols experiment. I will consider the implications of such limitations shortly.

5.7 Reported and observed use of memorisation strategies The prediction for memorisation strategies was that learners would report using these strategies frequently and would also use them frequently when observed. Thus a high level of consistency would be found between reported and observed use. Such high consistency was only found with the re-reading strategy, and then only with good learners. Both good and poor learners reported using the re-reading strategy more frequently than any other strategy. However, good learners used the re-reading strategy frequently while poor learners did not. Furthermore, with good learners the consistency between reported and observed use of re-reading improved with experience. This finding is supported in the verbal protocols experiment (described in chapter 2) as re-reading was used with far greater frequency than any other reading strategy (apart from inferencing discussed below); and good learners re-read the text more frequently than poor learners. In contrast, poor learners overestimated how frequently they re-read the text in all 3 years. This implies that good learners have the declarative knowledge of what this strategy is and why it should be used as beginning undergraduates; but the procedural knowledge of how to use this strategy seems to improve with experience. In contrast, poor learners may have the declarative knowledge of re-reading but lack the procedural knowledge of how to use the strategy. Alternatively, rather than lacking procedural knowledge poor learners may simply lack the motivation to use this strategy when reading.

Consistency between reported and observed use was also high with the memorisation strategies of restatement and linking the text to knowledge, although this was characteristic of only a minority of learners. About one-third of the good learners and one-quarter of the poor learners said they used both of these strategies frequently and also used them when observed. The percentage of good learners who reported and used these strategies frequently was quite stable over the three years, ranging mostly from 31% to 38%. The percentage of poor learners who reported and used these strategies frequently was less stable, ranging from 16% to 58%. However, these perceptions of strategy use are at odds with observations from the verbal protocols experiment (see chapter 2) where restatement and linking the text to prior knowledge were used more frequently than any other strategies; and the use of these strategies also increased from year 1 to year 3. This contrasts the findings that most learners reported using restatement and linking text to prior knowledge only *occasionally* or *infrequently*; and that reported ratings did not increase with experience. Put simply, most learners use these strategies when reading; but believe they use them only sometimes or infrequently. One explanation for this inconsistency may be the way the learners interpreted the use of *prior knowledge*. As stated in the methods section, prior knowledge can be used in a number of different ways such as inferring the referent of a pronoun; making bridging and elaborating inferences and drawing implied conclusions (Pressley & Afflerbach, 1996). In fact, in the verbal protocols experiment restatements were not distinguished from other instances of using prior knowledge as even restating the text in your own words usually involves substituting one word for another or making bridging inferences. Perhaps the learners did not know this range of behaviours involved the use of prior knowledge; and if learners interpreted prior knowledge as 'prior knowledge of the topic of the text' - then they would probably under-estimate their use of this strategy. I suspect this misguided interpretation of prior knowledge explains why observed use was greater than reported use.

With the remaining memorisation strategies both groups seemed to have optimistic perceptions about how frequently they use these strategies. Taking notes, underlining, identifying important points, summarising and defining unfamiliar terms were all frequently reported but rarely - or never - observed. Furthermore, the failure to use these strategies was apparent in all 3 years of study. It seems that learners have the declarative knowledge of what these strategies are, but fail to put this knowledge into practice when reading. There are several reasons why this may have occurred. First, learners may not use the strategies they say they use. Phifer & Glover (1982) stress that reported use of strategies "*may not necessarily imply that learners will in fact employ them or employ them in efficacious ways*" (pp 194). To overcome this problem some verification is needed to check that learners actually use the strategies they say they use. One way to achieve this is to combine the process approach with a product that can be analysed.

For example, think aloud protocols give an indication of cognitive processes such as a student's awareness of strategies. In contrast written summaries are a measure of the product of comprehension and can give an indication of strategies that are actually used. By combining the process approach with a product that can be analysed, the strategies learners say they use can be verified with the strategies they actually use. Written summaries were obtained in this thesis and are investigated in the next chapter. However, the summaries were included to investigate the effects of prior knowledge and the type of representation constructed during reading rather than actual strategy use. Although some strategies, such as the linking of text segments through inference can be verified, this was not the original intention.

Second, the confines of the experimental setting may have affected the strategies learners use when reading. Perhaps the learners didn't realise they could take notes or underline parts of the text in the think aloud experiment. Although pencils, pens and paper were provided, no specific instructions were given about what strategies could be used to avoid the implication that some strategies should be used rather than others. A third reason could be that the act of thinking aloud in the verbal protocols experiment somehow influenced the way learners read the text; and hence the strategies they used. Learners would not normally voice all their thoughts aloud, and they may have been concentrating on this task which may have had a detrimental effect on strategy use. Also, the reading strategies questionnaire asked the learners to say how frequently they used a variety of strategies, but didn't address the problem that strategy use will vary depending upon the subject being study and the task to be carried out (Thomas & Rowher, 1985). For example, the item "relate the material to what I already know" will be influenced by familiarity with the text, and self-reports must be restricted by not allowing for this variant.

5.8 Reported and observed use of understanding strategies The prediction for understanding strategies was that learners would report using these strategies frequently but use them infrequently when observed. Thus a low level of consistency would be found between reported and observed use of understanding strategies. None of the understanding strategies were used frequently, so this part of the prediction was upheld. However, reported use is less clear cut. Some of the understanding strategies were reported as more frequently used than others; but again this was not characteristic of all learners. With identifying unfamiliar terms, poor learners over-estimated their use in the first year; but reported use was close to observed use with one-third of these students in the second year and one-quarter of the students in the final year. With good learners, reported use of identifying unfamiliar terms consistently exceeded observed use in all 3 years. With monitoring comprehension, awareness matched production for both groups; and both reported and observed use increased from the first to the third year. However, only 30% of good learners and 16% of poor learners reported and used the monitoring strategy in their final year. In the verbal protocols experiment, between groups differences in monitoring were not found although good learners outperformed poor learners with monitoring in their final year, and monitoring did increase with study experience. The worrying implications from these findings are that many of students monitor their comprehension only sometimes or infrequently. However, the finding that monitoring appears to increase with experience is encouraging.

With the remaining understanding strategies, a high level of consistency between reported and observed use was found as reported use and observed use were infrequent. Outlining the text, looking for logical relations, linking different segments of the text, thinking how to use the information, asking questions and predicting the text are both perceived and observed to be infrequently used. Whether students are unaware of these strategies; or aware of the strategies but fail to employ them is not clear. What is clear, is the need for practical instruction: students need to have the declarative knowledge of what these strategies are and how they can enhance understanding, as well as the procedural knowledge of how to use these strategies. A better understanding of the training students received prior to entering university could inform instruction at the university level. Students need to be better prepared to cope with the demands of independent study at university. Brennan and colleagues (1986) stress "*it is often assumed that students know how to study effectively; however, there is evidence that many students entering college do not know how to tackle the demands of college work*" (pp 353). If university lecturers had a better understanding of the limited skills of beginning undergraduates, then they could help to increase the students' awareness and use of these strategies

5.9 Reported and observed use of critical thinking strategies The prediction for critical thinking strategies was that reported and observed use would be infrequent. Thus a high level of consistency between reported and observed use would be found. This prediction was upheld as linking text to past experiences, to one's beliefs, and to one's emotions, drawing diagrams, and challenging the author were all infrequently reported and observed. In chapter 4 critical thinking was defined as 'a process for determining the value of an idea, a concept, a solution, or information' (Freiberg & Driscoll, 1992); and 'a process which is associated with inquiry and decision making' (Raths, 1986). In this study the learners seem to be unaware that critical thinking strategies can enhance this process of evaluation and decision making as they did not report using them and failed to use them when observed. Perhaps the failure to use critical thinking strategies is linked to the failure to reach the highest stage of reading (described by Chall (1979, 1983) in section 1.4 of the literature review) which requires learners to engage in "*wide reading of ever more difficult materials, reading beyond one's immediate needs ... that calls for the integration of varied knowledge and points of view*". This stage of reading does not occur exclusively in formal education, and does not seem to occur in every individual. According to Fitzpatrick (1994) the students' failure to use critical thinking strategies is not surprising given that critical thinking is not encouraged in the classroom. Fitzpatrick stresses the need to instruct students in the use of these high-level strategies and outlines a variety of instructional aids to encourage critical thinking such as co-operative learning and higher order questioning.

To summarise, the findings in this chapter support those of Simpson (1984) who found beginning undergraduates used a restricted range of strategies; relied heavily on low-level strategies such as re-reading and underlining; and frequently failed to use high-level strategies such as planning, checking, evaluating and regulating performance. Similarly, Brennan et al (1986) found that students had a "*preference for underlining while reading but with little activity before or after reading*". The learners in this study had a preference for re-reading rather than underlining, but apart from this these findings are remarkably similar to those of Simpson and of Brennan et al. These findings have important implications for practitioners in higher education as they challenge the assumption that university graduates have developed competent strategies for study. Many learners seem poorly prepared for the demands of independent, undergraduate study. With some strategies, such as identifying important information, students have optimistic perceptions which suggests they have a superficial understanding of what they should be doing, but the discrepancy between reported and observed use shows this superficial understanding is not translated into action. With critical thinking strategies students lack even this superficial understanding and show neither awareness nor production of these strategies when reading. This lack of metacognitive knowledge shows that instruction is needed both with the development of declarative knowledge about what strategies are and how they can enhance understanding; and with procedural knowledge of how to use these strategies in practice. The worrying picture of ill-prepared undergraduates entering higher education with little understanding of how to cope with the demands of independent study is being increasingly recognised. The challenge to educators therefore, is to provide the students with an understanding of the benefits of independent learning, as well as the necessary knowledge and skills to become independent learners.

Chapter 6

Representation, prior knowledge and inference

6.1 Aims The final characteristics investigated in this thesis are representation, prior knowledge and inference. Evidence has shown that prior knowledge can facilitate reading. For example, child chess experts recalled more chess positions than adult chess non-experts showing that domain specific knowledge can compensate for the memory and metacognitive deficits of children (Chi et al, 1978). College students with more prior knowledge have been shown to be more proficient at learning text content than less knowledgeable students (Brooks & Dansereau, 1983). Knowledge can also help readers identify important information and make inferences when reading (Recht & Leslie, 1988)

When reading new material, prior knowledge should be activated if learning through understanding is to be achieved (Bransford & Johnson, 1972). However, more current thinking suggests that activation of prior knowledge may lead to remembering rather than understanding. Stevenson & Palmer describe the difference between using prior knowledge to understand and to remember. If new information has only been superficially integrated with prior knowledge then understanding will be superficial. For understanding to occur a two-way process of evaluation is needed. "*Learning through understanding goes beyond the simple integration of new information with prior knowledge in long term memory. Instead, deliberate effort is needed to make sense of new information by using prior knowledge .. as well as updating previous ideas to accommodate the new information*". (Stevenson & Palmer (1994) p 178). If prior knowledge is not evaluated in light of new information, then conflicting information can accumulate in long term memory without the learner realising it. A critical aspect of undergraduate study is the ability to integrate new information with one's pre-existing knowledge base.

The facilitative effects of prior knowledge were observed in the verbal protocols experiment described in chapter 2. The generation of inferences was investigated and the findings were that inferencing increased with study experience; warranted inferences were more frequent with familiar texts; and unwarranted inferences were more frequent with unfamiliar texts. Furthermore, good learners made more inferences than poor learners, and also made more inferences when reading unfamiliar texts suggesting that learning ability (in terms of exam performance) can facilitate inferencing even when prior knowledge is lacking. Taken together these findings support the view that prior knowledge facilitates the generation of inferences (McNamara, Kintsch, Songer & Kintsch; 1996). In contrast, when prior knowledge is lacking readers don't have a rich set of constraints and are more likely to draw inferences that are not plausible.

The main question arising from these findings was what underlies the good learners' superior inferencing skills. One possibility is that good learners have a richer knowledge base, another is that they construct a different type of representation when reading. The main aim of this chapter is to investigate prior knowledge and representation more directly. This is undertaken in two ways. First, the *type of representation* constructed during reading is investigated with written summaries of the main ideas produced after reading. Second, *prior knowledge and memory for the text* are investigated more directly with specifically devised questions on the content of the texts.

6.2 Representation of text content In the literature review Kintsch's (1994) distinction between remembering and understanding material was explained in terms of the representation constructed during reading. To recap briefly, Kintsch (1988) distinguished 3 types of representation constructed during reading. A surface representation encodes the words and linguistic relations between the words; a textbase representation stores the semantic and rhetorical structure of the text; and a situation model elaborates and integrates the textual content with prior knowledge. Kintsch (1994) distinguishes remembering and understanding in terms of the type of representation constructed when reading. A textbase representation is sufficient for superficial, verbatim recall while a situation model enables a deeper level of understanding because of the process of elaborating and integrating the text with prior knowledge.

Evidence has shown that prior knowledge affects the type of representation constructed. Voss & Silfies (1996) found that subject-matter knowledge was primarily related to situation model construction whereas reading comprehension skill was primarily related to textbase representation. Their study was described in section 1.9 of the introduction. Their argument was that as reading skill is related to working memory capacity good comprehenders should recall and store more textual information because of more efficient processing. In contrast, situation model construction requires the integration and elaboration of text content with prior knowledge, therefore prior knowledge of the topic of the text should facilitate the construction of situation models. These predictions were upheld as prior knowledge did facilitate the construction of situation models.

Given this framework the good learners in this study should be more likely to construct a situation model of the text, because they are more likely to have more - or better organised prior knowledge of the topic of the text. In contrast, poor learners are more likely to focus on textual details. This prediction was investigated with summaries written by learners after reading the expository texts in the verbal protocols experiment. Construction of a situation model was quantified by the type of main ideas produced in the written summaries. Five types of ideas were identified; local, global, topic, general and incorrect ideas. The categorisation procedure together with examples of these ideas are outlined in the results section. Evidence from studies of written summaries suggests that good readers focus on the main points and recall more global ideas which require inferencing, while poor readers focus on textual details at the cost of understanding the main ideas (Commander & Stanwick, 1997). In terms of this study, good learners are expected to produce more global ideas than poor learners because they are more likely to elaborate and integrate the text content with prior knowledge.

6.3 Prior knowledge and memory for text content A more direct approach was taken in the third year to investigate the learners' prior knowledge. Before reading the texts, learners were given **prior knowledge questions** to test their subject knowledge of the topic of the text. After reading each text learners were given **textbase questions** which tested superficial memory of the text as answers were located in one sentence of the text. After answering the textbase questions learners were given **inference questions** which tested a deeper level of understanding as answers required information from separate sentences to be linked. The categorisation procedure together with examples of the questions are outlined in the results section. The predictions were that; good learners will answer more prior knowledge questions correctly because they will have more prior knowledge of the topic; and good learners will answer more inference questions correctly because they will be more likely to integrate different segments of the text.

Method

6.4 Subjects Written summaries were obtained from the 13 good and 12 poor learners who took part in the verbal protocols experiment in the first, second and third year. The prior knowledge, textbase and inference questions were given to 15 third-year learners who took the Cognitive Science course. Of these 15 learners, 5 were later identified as good learners and 7 were later identified as poor learners from their final median exam scores. 3 learners had median exam scores which fell between the accepted range for good and poor learners and were excluded from the results to accentuate the difference between the 2 groups. Therefore prior knowledge, textbase and inference questions will be analysed with 5 good and 7 poor learners.

Materials No separate materials were required for the investigation of written summaries. The texts the students read before writing the summaries were described in the verbal protocols experiment (see section 2.6) and are included in the appendix, table A2.4. The main ideas from the summaries were categorised as local ideas, global ideas, topic ideas, general ideas and incorrect ideas. The criteria used for categorisation were: local ideas reflected information from one sentence in the text; global ideas reflected the linking of two or more sentences in the text; incorrect ideas were not consistent with the text content; topic ideas concerned the subject of the text; and general ideas reflected the reader's background knowledge (rather than text content) or information so general that it did not specifically relate to the text content. Examples of these ideas are shown below:

Text. Our evidence for spatial descriptions suggests a theory of comprehension in which there are two stages. (1) In the first stage, a superficial understanding of an utterance gives rise to a propositional representation, which is close to the surface form of the sentence. (2) This symbolic representation is constructed in a mental language that has a vocabulary of comparable richness to that of natural language. (3)

Local idea	*"The formation of a propositional representation is similar to the actual sentence."*
Global idea	*"The propositional representation uses a similar vocabulary to natural language and has a very basic understanding."*
Topic idea	*"This text was about representing language."*
Incorrect idea	*"The theory had three component parts."*
General idea	*"I think it's Johnson-Laird ."*

The prior knowledge, textbase and situation model questions were designed by myself and the lecturer responsible for the Cognitive Science module. 8 prior knowledge, 8 textbase and 8 inference questions were devised for the familiar and unfamiliar third-year cognitive psychology texts. Two versions of each text were used to test for effects of the materials. Consequently 4 third year Cognitive Science texts were used: the familiar "version 1" text concerned the topic of reasoning; the familiar "version 2" text concerned the topic of coherence and plausibility of discourse; the unfamiliar "version 1" text concerned the topic of decomposition; and the unfamiliar "version 2" text concerned the topic of the representation of meaning. These texts can be found in the appendix, Table A2.4.

The lecturer with responsibility for the third year Cognitive Science course knew what topics and reading materials should be familiar and unfamiliar to the learners. This lecturer therefore devised 8 prior knowledge questions for each text: One set of 8 prior knowledge questions related to the topic of the familiar text on reasoning; and 8 prior knowledge questions related to the topic of the familiar text on discourse. The same 8 prior knowledge questions were used with the version 1 and version 2 unfamiliar texts because both texts concerned the same general topic of word meanings. Familiar topics were introduced to the learners in their second year, and because the experiment took place in the first term of their third year, the topics should be familiar but the content of the texts should not be instantly recognisable. Unfamiliar topics were introduced to the learners in the second term of their third year, so when the experiment was carried out the learners should have been unfamiliar with the topic and content of the text. All prior knowledge questions concerned the *topic* of the text and did not specifically concern the actual text content. Textbase questions were designed to test for a superficial memory of the text content and answers to these questions were located in one sentence of the text. Inference questions were designed to test for a deeper level of understanding and answers to these questions required information from one of more sentences to be linked. 8 textbase questions and 8 inference questions were designed for each of the 4 texts. A full list of all questions are included in the appendix: Table A6.1 (familiar version 1 text); Table A6.2 (familiar version 2 text); Table A6.3 (unfamiliar version 1 text); and Table A6.4 (unfamiliar version 2 text). An example of each type of question is given below.

Prior knowledge question for the third year familiar version 1 text on reasoning
"What is the difference between deductive and inductive reasoning?"

Prior knowledge question for third year unfamiliar version 1 & 2 texts on word meanings
"What is the difference between "sense" and reference"?

Textbase question for the third year familiar version 2 text on coherence and plausibility
"Why must coherence be distinguished from plausibility in discourse?"
(Answer is found in sentence 4).

Textbase question for the unfamiliar version 1 text on decomposition
"What was concluded about the use of the word bachelor compared to the word unmarried?"
(Answer found in sentence 17).

Inference question for the familiar version 1 text on reasoning
"Explain the logical properties of the relational expression 'next to'?
(Answer found in sentences 29 and 31).

Inference question for the unfamiliar version 1 text on decomposition
"The evidence described in the text was said to be equivocal. What evidence was this?
(Answer found in sentences 8 and 9).

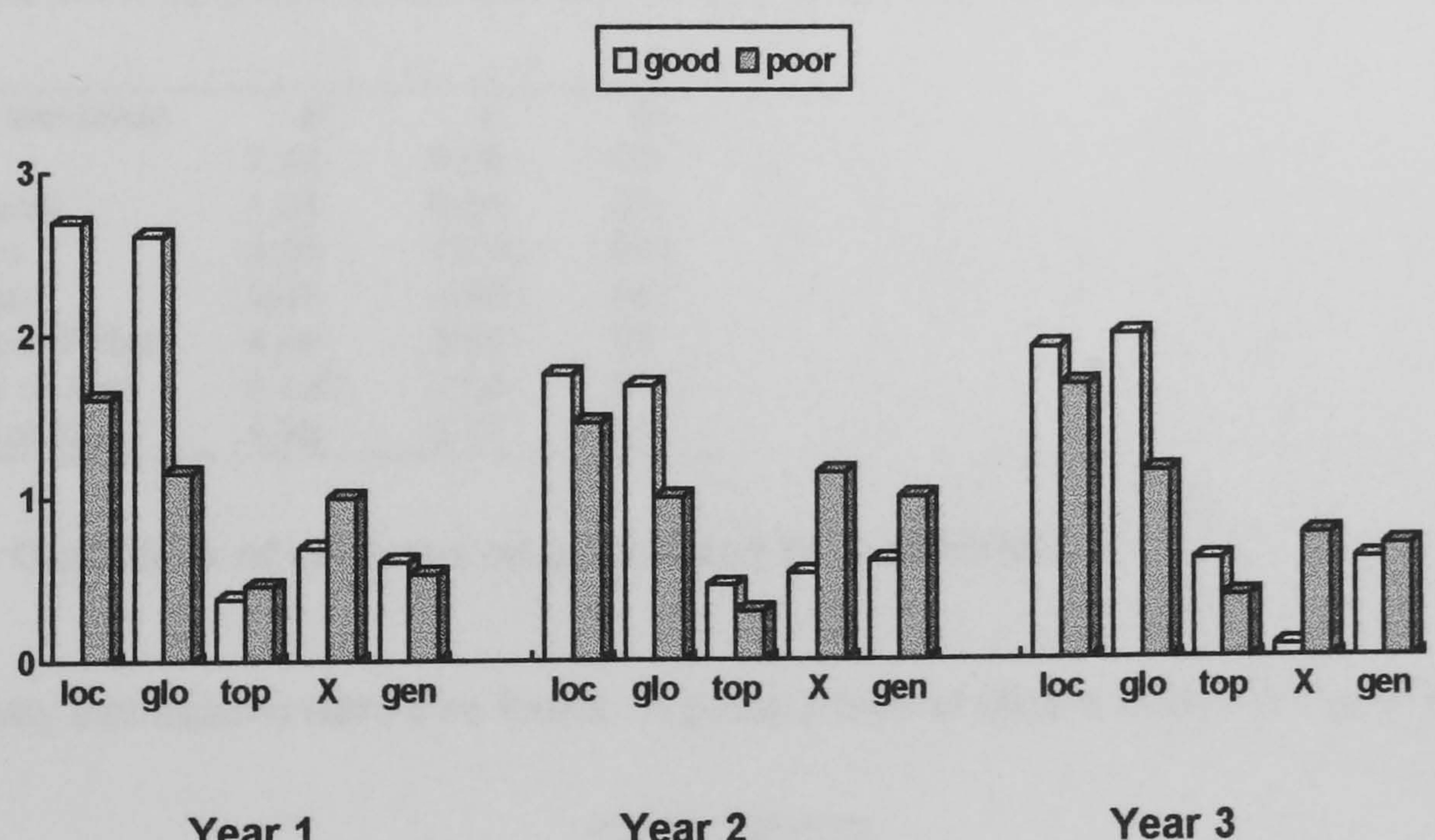
Design and Procedure Analysis of the written summaries was undertaken with one between subjects factor and two within subjects factors. The between subjects factor of **group** compares good and poor learners (identified by final exam scores). The within subjects factor of **year** compares learners' performances across 3 years of study (year 1 vs. year 2 vs. year 3); while the within subjects factor of **text familiarity** compares learners' performances reading familiar and unfamiliar texts. Analysis of the prior knowledge, textbase and inference questions was carried out only in the third year, therefore the within subjects factor of year of study was not included. The design therefore included the between subjects factor of group and the within subjects factor of text familiarity, both described above.

Instructions in the verbal protocols experiment asked the learners to write down the main points of each text when they had finished reading it. The text was removed when learners indicated they had finished reading the text and were ready to write a summary of the main ideas. The procedure for answering the prior knowledge, textbase and inference questions was as follows. Before beginning to read each text the learners were given 8 prior knowledge questions. When they had completed the prior knowledge questions the learners began to read each text, thinking aloud their thoughts as they did so. When learners had finished reading the text and thinking aloud their thoughts, the text was removed and the learners were asked to write a summary of the main points of the passage. When this was completed, the learners were given the textbase questions; and after completing the text base questions they were then given the inference questions. The time taken for each student to answer each set of 8 questions was recorded. The questions were always given in the following order; prior knowledge > textbase > inference. The 8 prior knowledge questions were randomly presented, as were the 8 textbase questions and the 8 inference questions. The order of presentation of familiar and unfamiliar texts was counterbalanced; and half the learners were randomly given version 1 familiar and unfamiliar texts, while the other half were randomly given version 2 familiar and unfamiliar texts.

Results

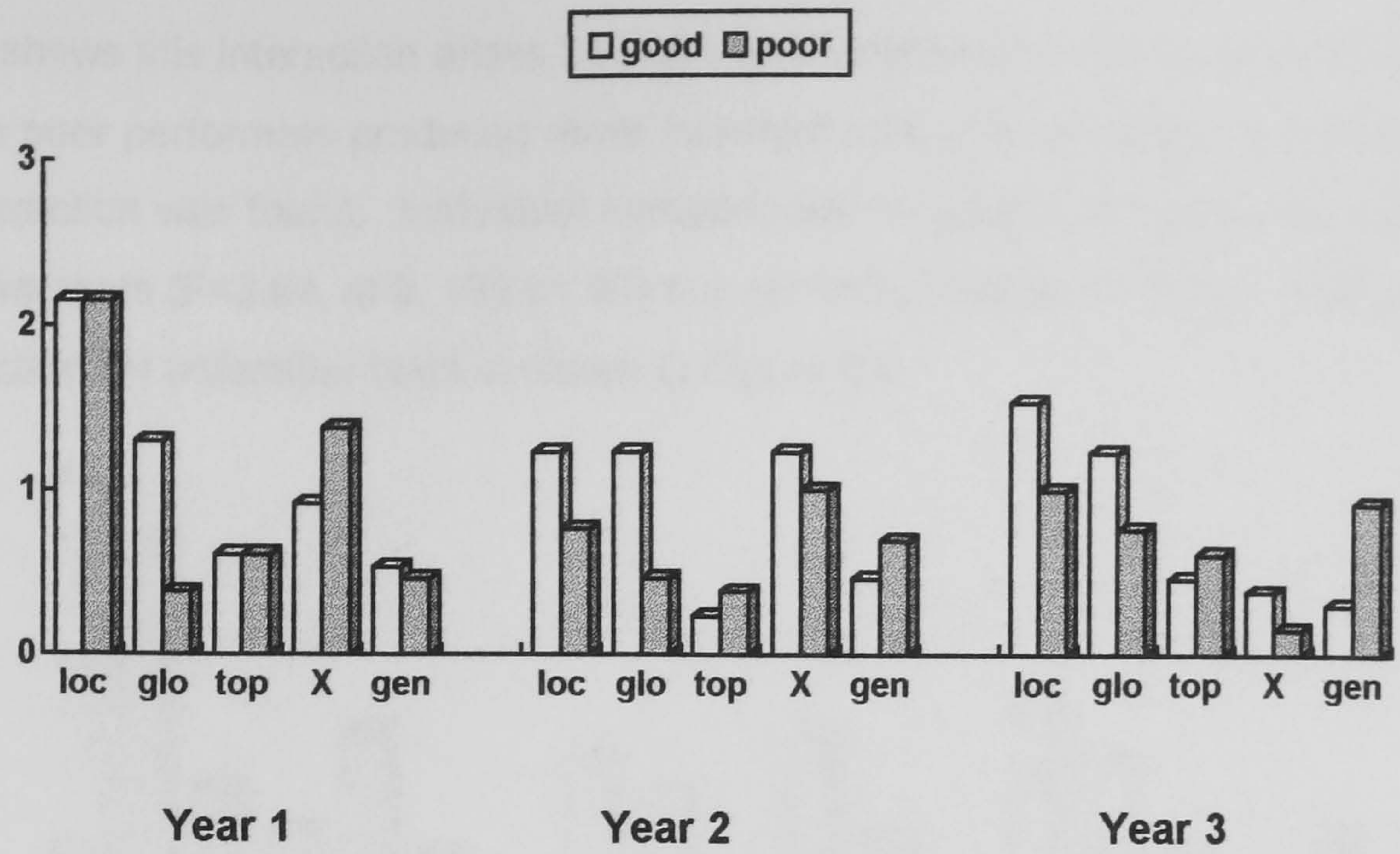
The results are described in two stages. In stage 1 analysis of the written summaries is reported. In stage 2 analysis of the prior knowledge, textbase and inference questions is reported.

6.5 Analysis of summaries The categorisation procedure was carried out by the author and a sample was categorised by a second independent judge. For each year inter-rater reliability (Cohen's Kappa) was high: yr 1 k = 0.75; yr 2 k = 0.80; yr 3 k = 0.87. The mean number of main ideas for good and poor learners is shown in Figure 6.1 (familiar texts) and Figure 6.2 (unfamiliar texts). The outcomes of analysis on these data are shown in Table 6.1. ANOVA tables of these means together with tables of all other measures are given in the appendix, tables A6.5 - A6.11.



Code: **loc** local; **glo** global; **top** topic; X incorrect; **gen** general

Figure 6.1 Mean number of main ideas in written summaries: familiar texts.



Code: **loc** local; **glo** global; **top** topic; X incorrect; **gen** general

Figure 6.2 Mean number of main ideas in written summaries: unfamiliar texts.

Analysis of the main ideas in the summaries revealed that more ideas were produced in year 1 (1.1) than year 2 (0.9) or year 3 (0.9); more ideas were produced with familiar (mean 1.1) than unfamiliar (mean 0.9) texts; and that local ideas were the most frequent (mean 1.7), followed in descending order by global (1.2); incorrect (0.8); general (0.6) and topic (0.4).

source of variation	df	F	p
year	2,48	4.06	.02
text familiarity	1,24	8.54	.01
type of idea	4,96	15.92	.000
group x year	2,48	0.48	ns
group x type of idea	4,96	3.65	.01
year x type of idea	8,192	2.06	.04
text x type of idea	4,96	3.77	.01

Table 6.1 Outcomes of analyses on main ideas in summaries.

Three 2-way interactions were also found. A group x type of idea is shown in Figure 6.3.

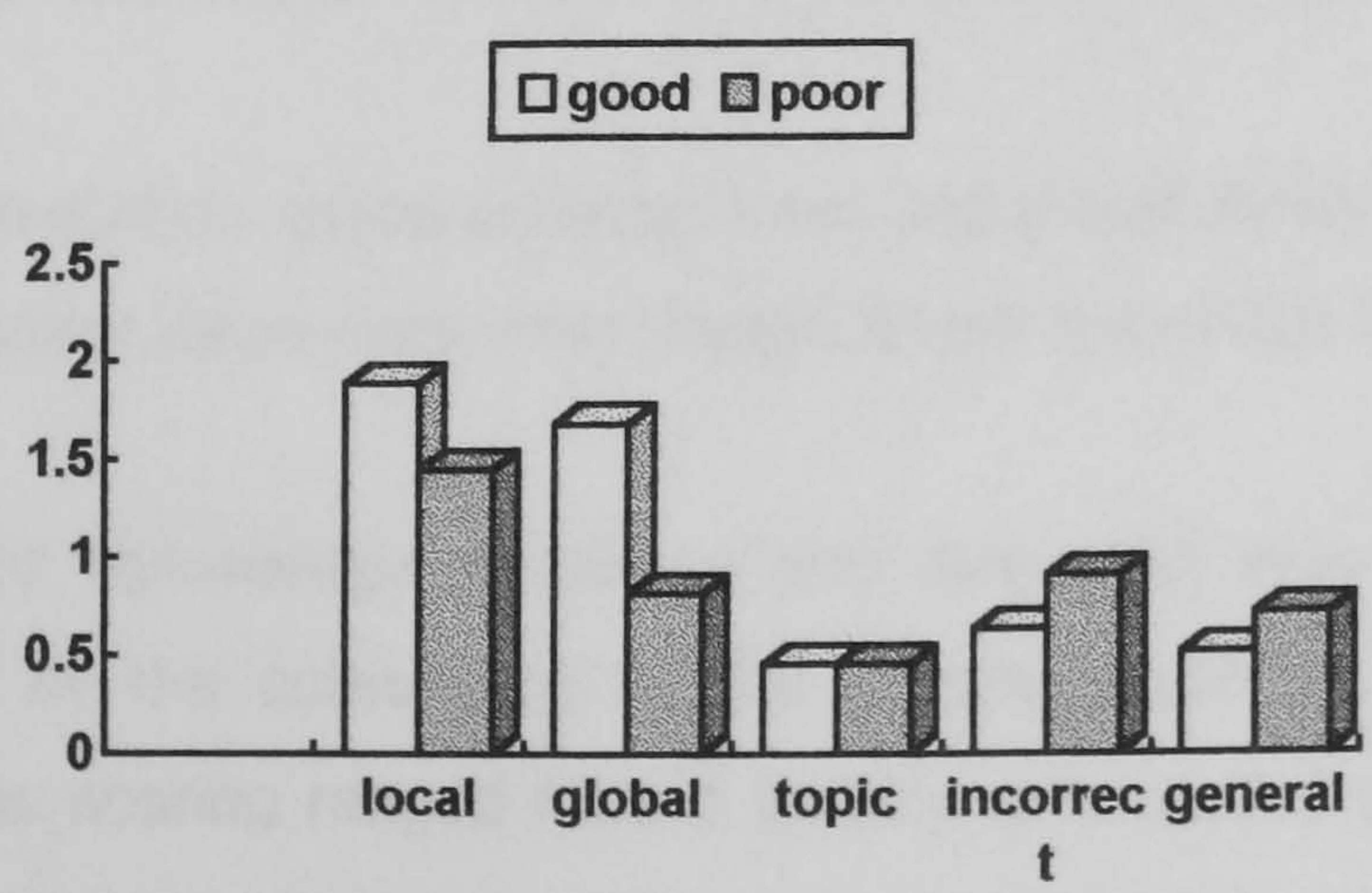
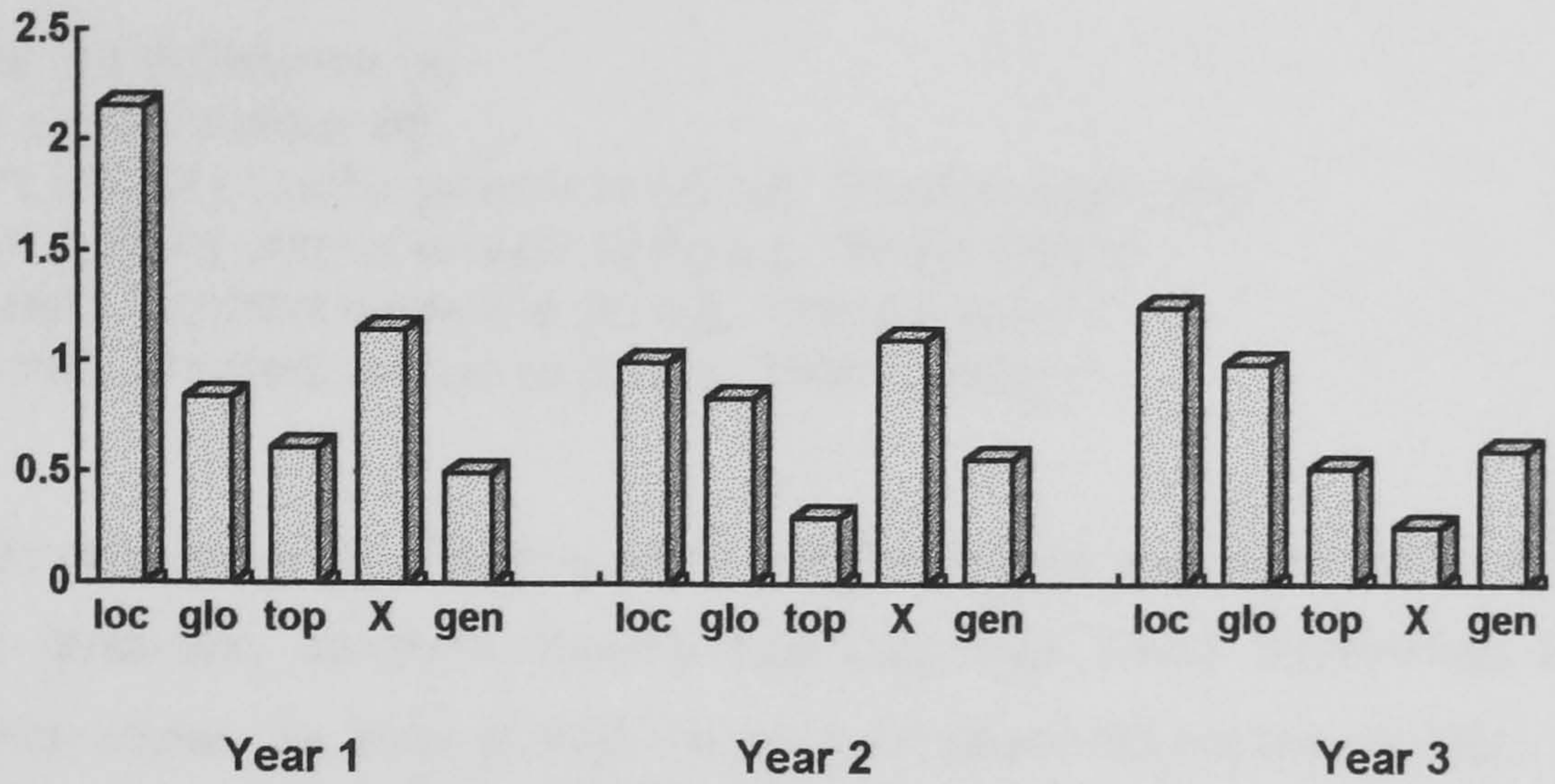


Figure 6.3 Group x type of main idea interaction with written summaries.

Figure 6.3 shows this interaction arises because good learners produced more local and global ideas while poor performers produced more incorrect and general ideas. A 2-way year x type of idea interaction was found. Individual comparisons revealed this interaction was significant for unfamiliar texts ($F=3.64$, df 8, 192 $p<.01$) but not for familiar texts ($F<1$). The year x type of idea interaction for unfamiliar texts is shown in Figure 6.4.



Code: **loc** local; **glo** global; **top** topic; **X** incorrect; **gen** general

Figure 6.4 Year x type of main idea interaction with written summaries: unfamiliar texts

Figure 6.4 shows the year x type of idea interaction arises because local ideas were greatest in year 1, global ideas were greatest in year 3, and incorrect ideas were fewer in year 3. The 2-way text by type of idea is shown in Figure 6.5.

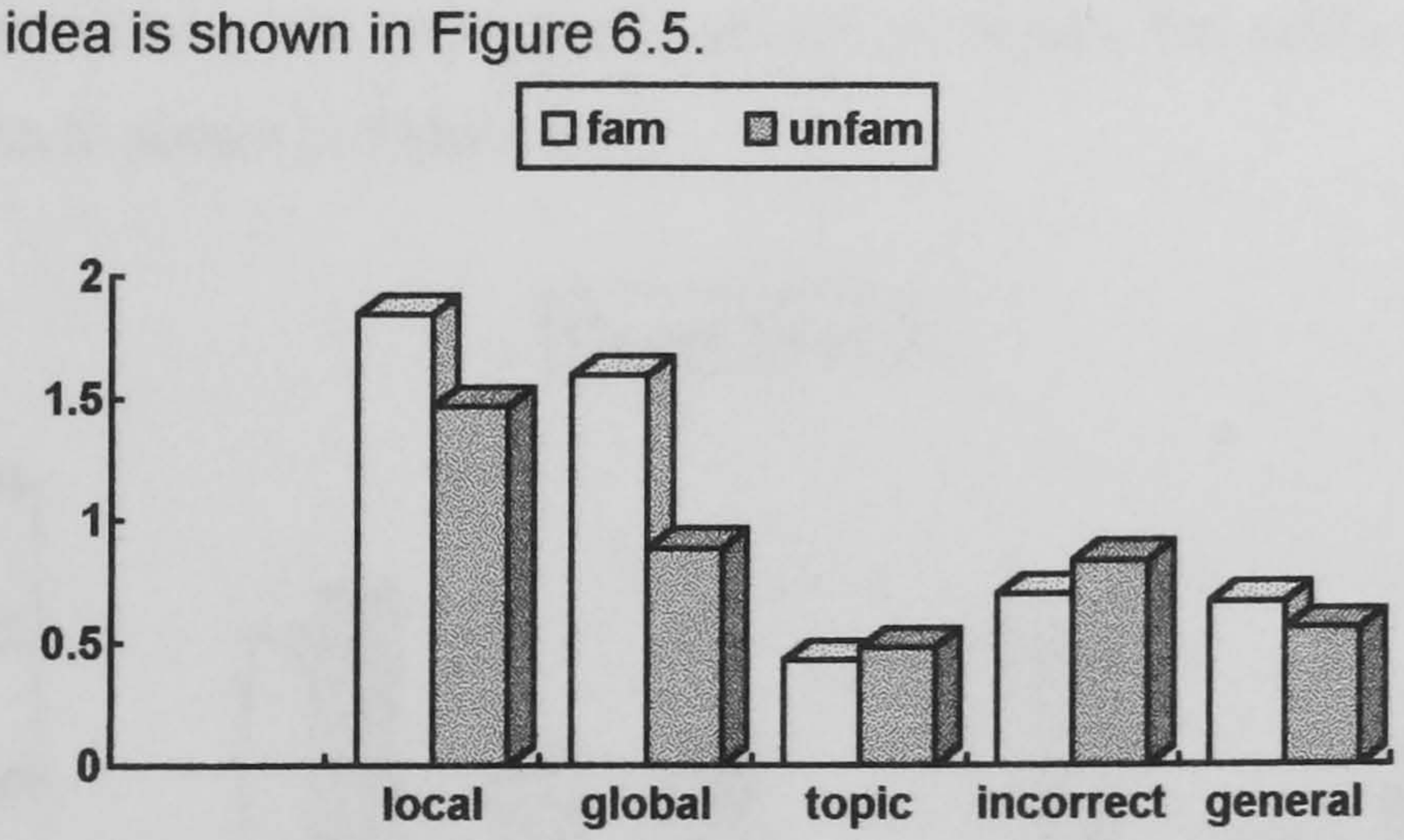


Figure 6.5 Text x type of main idea interaction with written summaries.

Figure 6.5 shows the interaction arises because local and global ideas were more frequent with familiar texts while incorrect ideas were more frequent with unfamiliar texts.

6.6 Analysis of prior knowledge, textbase and inference questions The answers to questions were scored by the author and by the lecturer teaching the third year cognitive psychology course. The scoring ranged from 1 (totally correct); 0.5 (partly correct and partly incorrect); 0.25 (mostly incorrect but some accuracy); and 0 (totally incorrect). To illustrate this procedure an example of a textbase question is given.

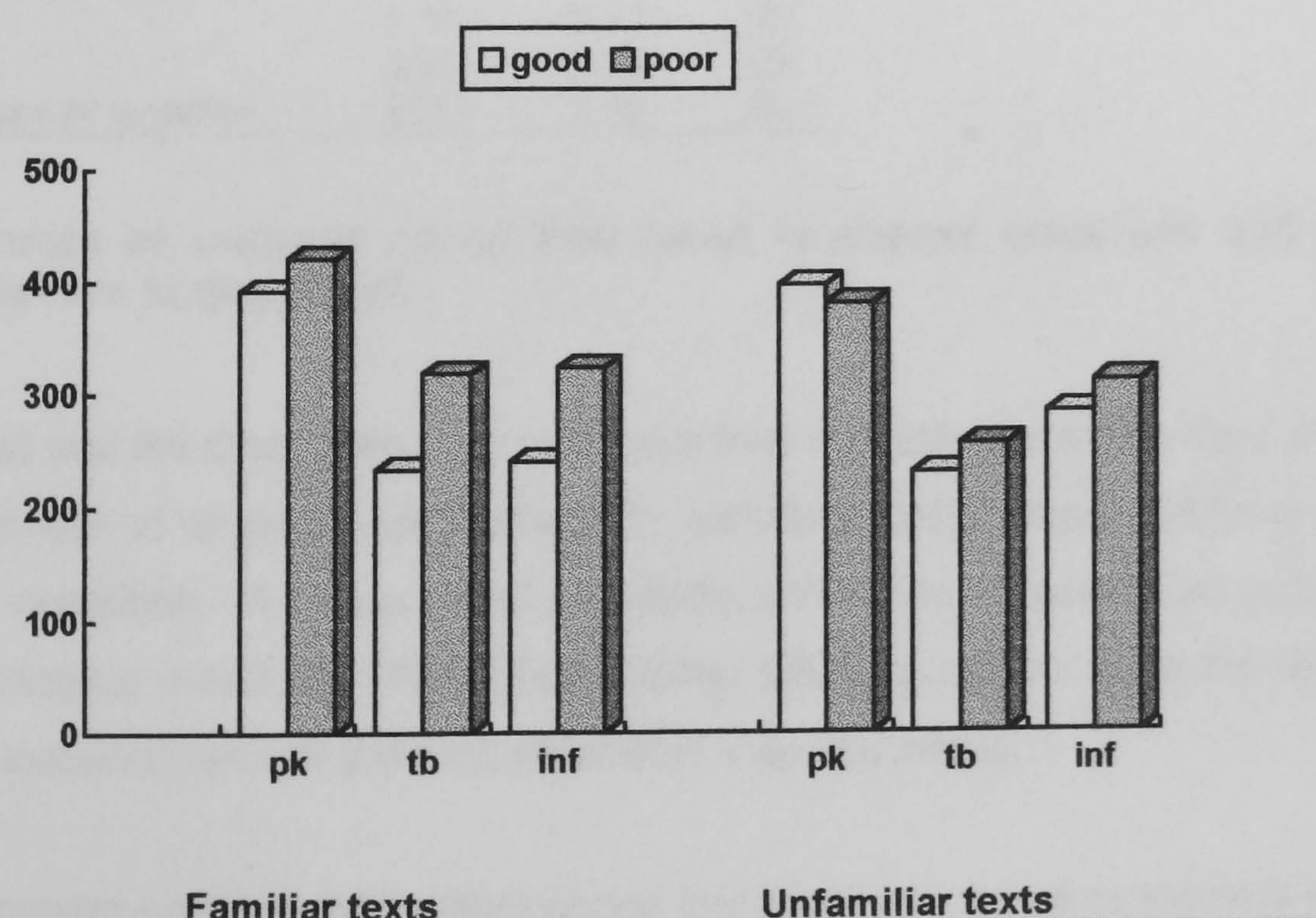
Text: In our first experiment, the subjects listened to a list of thirty-six words and classified each of them as a positive or negative instance of a category defined on the basis of three components.

Question: In the author's experiment, the subjects listened to a list of thirty-six words and classified them as ______________________ (a) on the basis of ____________________ (b)

Correct answer for (a)was "**positive or negative instances**".
Correct answer for (b) was "**3 components**".

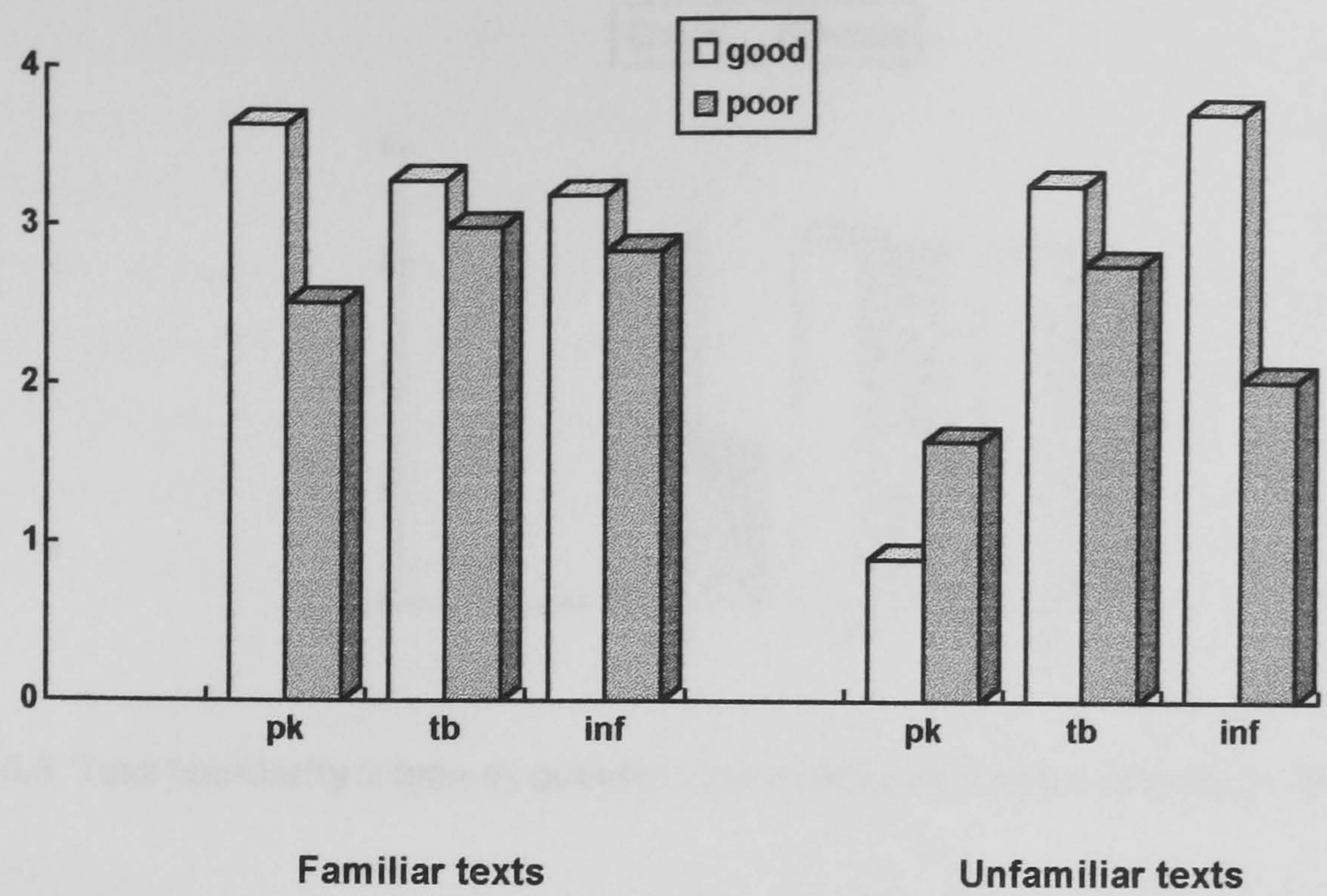
Scored 0.5 for correct answer (a)
Score 0.5 for correct answer (b)
Score 0.25 for partially correct answer to (a) e.g. *"positive examples"*
Score 0.25 for partially correct answer to (b) e.g. *"components"*
Score 0 for totally incorrect answer to (a) e.g. *"being similar"*
Score 0 for totally incorrect answer to (b) e.g. *"their meaning"*

Each question received a maximum score of 1 if the answer was totally correct. With some of the textbase questions, students showed that they had linked information from different sentences when answering, even though the correct answer did not require this. However, this occurred very infrequently; only 4 of the 96 answers to textbase questions reflected information from more than one sentence of the text. A reliability statistic (Cohen's Kappa) of 0.63 was obtained which was lower than anticipated, probably due to the difficulty with the scoring of answers to prior knowledge questions. Both judges therefore looked at conflicting scores and reached agreement on the coding of all answers. When agreement was reached, a total score of answers to questions was obtained by adding the individual scores for each question. The mean time taken to answer the questions is shown in Figure 6.6 while the mean scores for answers to questions is shown in Figure 6.7



Code: pk prior knowledge questions; **tb** textbase questions; **inf** inference questions

Figure 6.6 Mean times (seconds) to answer prior knowledge, textbase and inference questions.



Code: **pk** prior knowledge questions; **tb** textbase questions; **inf** inference questions

Figure 6.7 Mean scores for answers to prior knowledge, textbase and inference questions

The outcomes of analysis of variance on the data in Figures 6.6 and 6.7 is shown in Table 6.2.

source of variation	df	F	p
(a) time to answer questions			
type of question	2,20	13.35	.000
group x text	1,10	4.65	.05
(b) mean scores from questions			
text familiarity	1,10	9.11	.02
type of question	2,20	3.63	.05
text familiarity x type of question	2,20	3.29	.05

Table 6.2 Outcomes of analyses on (a) time taken to answer questions and (b) mean scores from answers to questions.

Analysis revealed that the time taken to answer questions was affected by the type of question. Students took longer to answer prior knowledge questions (397s) than inference (290s) or textbase (259s) questions. A group x text familiarity interaction revealed that good learners spent longer answering unfamiliar (304s) than familiar (288s) questions while the reverse was found with poor learners (familiar 354s vs. unfamiliar 316s questions).

With the mean correct scores a main effect of text familiarity was found as learners had higher scores with familiar (mean = 3.0) than unfamiliar (mean = 2.3) texts. A main effect of type of question was found as more textbase questions (mean 3.0) were answered correctly than inference questions (2.9) or prior knowledge (mean 2.1) questions. A 2-way text familiarity x type of question interaction was also found and is shown in Figure 6.8.

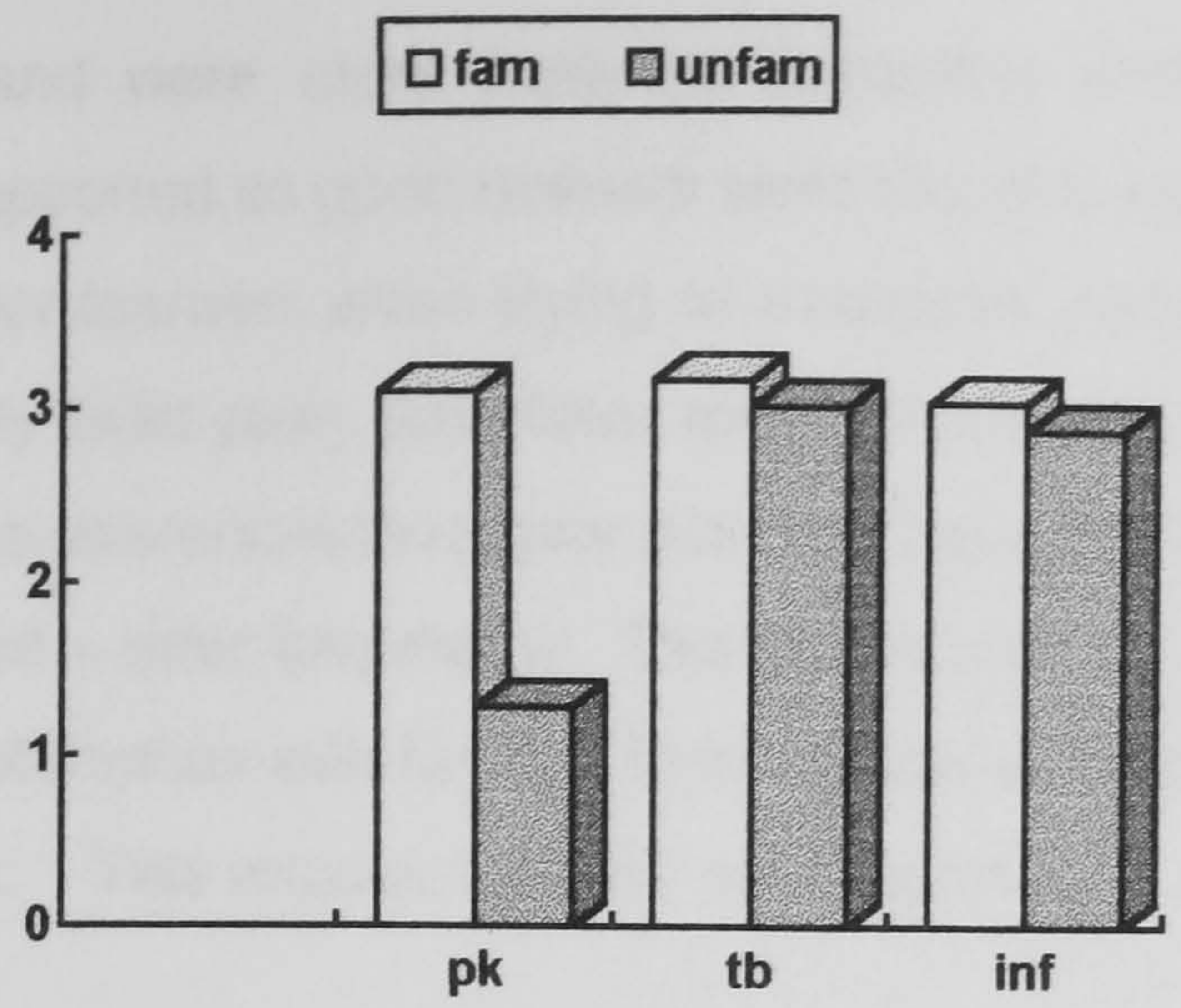


Figure 6.8 Text familiarity x type of question interaction with mean scores for questions.

Figure 6.8 shows this interaction arises because fewer correct answers were found with prior knowledge questions on unfamiliar topics. Individual analysis was then carried out to see examine between groups differences with familiar texts and unfamiliar texts separately. With familiar texts, no difference between the 2 groups or between the 3 types of question was found and the interaction between these effects was not significant (all F's <1). However, with unfamiliar texts, a significant 2-way interaction between the type of group and the type of question was found (F=.057, df 2,20 p.05). This interaction is shown in Figure 6.9.

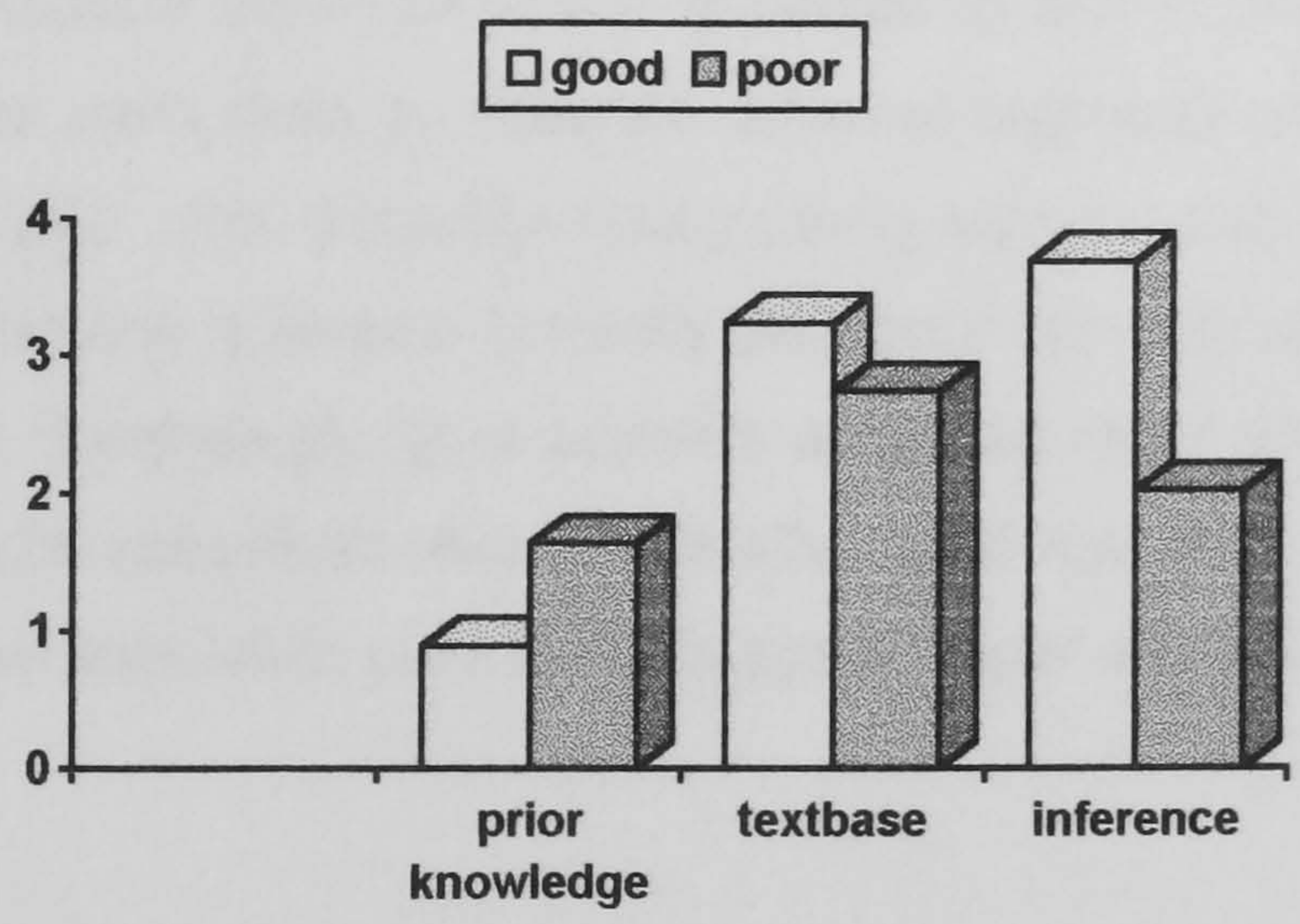


Figure 6.9 Group x type of question interaction for unfamiliar texts

The interaction in Figure 6.9 arises because good learners answered more textbase and inference questions correctly, and surprisingly, poor learners answered more prior knowledge questions correctly on the unfamiliar texts.

Discussion

Representation, prior knowledge and inference were investigated in this thesis in three ways. First, in the verbal protocols experiment the **effects of prior knowledge on strategy use and inferencing** were investigated by asking students to read familiar and unfamiliar texts. Strategy use was expected to be more frequent with unfamiliar texts when readers lacked background knowledge and were more likely to encounter comprehension failure. This prediction was partially supported as good learners were found to use more low-level strategies (e.g. re-reading) than poor learners when trying to overcome comprehension failure with the second-year (and probably third-year) unfamiliar texts. With inferencing, good learners were expected to generate more inferences than poor learners because they are more likely to have more - or better organised - prior knowledge. This prediction was upheld. Both groups were expected to make more inferences with familiar than unfamiliar texts because of the facilitative effects of prior knowledge. This expectation was not supported.

Second, the types of representation constructed during reading were investigated in the verbal protocols experiment by asking students to provide **written summaries** of the main points after reading. Good learners were expected to produce more global ideas because they would be more likely to construct situation models of the text during reading. This prediction was supported as good learners produced more global and local ideas whereas poor learners produced more incorrect and general ideas in their summaries.

Third, in the final year of this study questions were devised to test the students' prior knowledge and ability to link different parts of the text. Good learners were expected to answer more **prior knowledge** questions because they would have more - or better organised knowledge of the topic of the text. Good learners were also expected to answer more **inference** questions because they would be more likely to integrate different segments of text when reading and construct situation models. This prediction was partially supported as good learners answered more textbase and inference questions correctly than poor learners with unfamiliar texts - but not with familiar texts. Surprisingly, poor learners answered more prior knowledge questions than good learners with unfamiliar texts. Finally, good learners spent longer answering questions on unfamiliar texts while poor learners spent longer answering questions on familiar texts.

6.7 Verbal protocols experiment In the verbal protocols experiment text familiarity was expected to inhibit strategy use because strategies are more likely to be used when comprehension problems arise, such as when a reader's prior knowledge is insufficient (Bereiter & Bird, 1985). This prediction was partially supported as although no main effect of text familiarity on strategy use was found, good learners did use more low-level strategies such as re-reading when they expressed comprehension failure with the second-year (and possibly third-year) unfamiliar texts. In terms of inferencing, good learners were expected to make more inferences than poor learners, because they are more likely to have more - or better organised - background knowledge of the text content. More inferences were expected to be made with familiar than unfamiliar texts because prior knowledge has been shown to facilitate inferencing (e.g. McNamara, Kintsch, Songer & Kintsch, 1996). All students were expected to make more implausible inferences when reading unfamiliar texts because of the lack of a rich set of constraints that accompanies prior knowledge (Tardieu, Ehrlich & Gyselinck, 1992). These expectations were all upheld supporting previous observations of the facilitative effects of prior knowledge on inferencing.

6.8 Main ideas in summaries The types of representation constructed during reading were investigated in the verbal protocols experiment by asking students to provide written summaries of the main points after reading the familiar and unfamiliar texts. In terms of Kintsch's (1988, 1994) construction-integration model of text comprehension the production of local and global ideas reflects two levels of understanding. If the text is represented in the form of textbase representations then only a superficial level of understanding will be gained. Local ideas written in the summaries reflect this superficial level of understanding as they represent a near verbatim recollection of the text. If the text is represented in the form of situation models then a deeper level of understanding will be gained as the reader elaborates and integrates the text content with prior knowledge; and also integrates different parts of the text. Global ideas written in the summaries reflect this deeper level of understanding as they represent an integration of different ideas in the text. The finding that good learners produced more local and global ideas suggests that they formed locally and globally well-structured representations of the expository text. At a global level some inferences must be made to link the semantic information from one sentence to that of another. This inferencing process requires the construction of a situation model which facilitates a deeper understanding of the text as the representation becomes linked to the readers long-term memory and knowledge. The finding that poor learners made more incorrect and general ideas suggests they formed less well-structured representations, and that misconceived ideas were not corrected. Kintsch (1994) stresses that the textbase and situation model should not be thought of as two distinct mental structures. A reader constructs a single mental structure from the text, and the same elements are used in both types of representations, but in different ways. "*The problem does not lie at the textbase level of understanding but rather the inability to construct from that information a representation of the situation depicted.*" (McNamara, Kintsch, Songer & Kintsch; 1996 pp 4). The observation that poor learners produced more incorrect ideas than global, topic or general ideas suggests they failed to construct an adequate representation of the situation described in the text.

These findings support those of Commander & Stanwick (1997) who asked good and poor undergraduate and graduate readers to read either short (260 words) or long (620 words) texts and then write down all they could remember. The recollections were then scored for global and local ideas. The authors found that good readers had more accurate recall of global ideas regardless of the length of the text; but with local ideas good readers outperformed poor readers with shorter texts, but not with longer texts. The authors concluded that the poor readers "*may have focused on details at the cost of missing main ideas ... and perhaps good readers were more sensitive to the structural elements of a text and therefore had more accurate recall of main* *ideas*" (pp 49). In this present study good learners recalled more global ideas when writing summaries which implies they were able to link different parts of the text when reading. Good learners also produced more local ideas which implies they also remembered textual details. In contrast, poor learners produced more general ideas that weren't specifically related to the text content, and produced more incorrect ideas which implies a lack of comprehension monitoring. Commander & Stanwick (1997) argue that successful comprehension monitoring enables successful text representation: "*failure at monitoring may impede processing information at the textbase level and prevent learning or the deeper level of understanding that takes place with the formation of a situation model*" (pp 40). So perhaps a failure to monitor comprehension explains the poor learners' greater number of incorrect ideas. This explanation however, is not supported by observations of comprehension monitoring in the verbal protocols experiment as good learners did not outperform poor learners. An alternative explanation is that the demands of the task affected the poor learners ability to summarise the texts. In the present study learners were asked to write down what they thought were the main points. This contrasts Commander & Stanwick's method where the learners were asked to recall everything they could remember. When learners are asked to recall the main ideas this probably encourages the learners to be selective when writing summaries and they may have rejected ideas they remembered, but didn't consider to be important. This may have adversely affected the summaries of poor learners - if they focused on details at the cost of missing the main ideas when initially reading the texts, then they would find it difficult to summarise only the main points after reading.

In terms of **familiarity** with the texts, both groups produced more local and global ideas with familiar than unfamiliar texts. This is probably because it is more difficult to construct a representation of unfamiliar material, and therefore more difficult to generate ideas in the summaries. When reading unfamiliar texts the relationships between the concepts in the text are unknown and the structure of the text becomes important as it can help the reader develop relationships between the unknown concepts. With familiar material the conceptual relations are recognized so the structure of the text is less critical (Roller, 1990). The expository texts used in this study were taken from recommended undergraduate textbooks and were given to the learners without the usual study aids of headings, diagrams or summaries. The learners therefore had to work out the topic of the text as well as the author's intentions. According to Beck, McKeown & Gromoll (1989) texts for learners typically have unclear content goals, assume too much background knowledge and often have inadequate explanations. In this study learners were given relatively short texts usually taken from the middle of a chapter and they had no knowledge of what preceded or followed the chosen text; and had no clues about the topic of the text or the author's intentions. This makes the process of identifying relationships between the concepts and generating an interpretation of the meaning difficult. However, if the content of the text is also unfamiliar, then this process becomes even more arduous.

With unfamiliar texts, both groups produced more incorrect ideas which suggests the learners were producing ideas that were inconsistent with the unfamiliar material. In the verbal protocols experiment (see chapter 2) self-assessment of comprehension was significantly lower with unfamiliar than familiar texts showing that the learners felt their understanding of unfamiliar material was poor. These perceptions were supported by the production of fewer ideas in the summaries of unfamiliar texts. In terms of Glenberg & Epstein (1987) the students "*clunked*" (i.e. perceptions of poor comprehension are supported with subsequent poor performance) and did not have an "illusion of knowing" (i.e. perceptions of good comprehension are not supported with subsequent poor performance).

In terms of **study experience**, the findings are more difficult to interpret. A significant interaction between the year of study and type of idea was only found with unfamiliar texts; local ideas were greatest in year 1, global ideas were greatest in year 3, and incorrect ideas were fewer in year 3. Little difference was found with topic and general ideas across the 3 years. The finding of fewer incorrect ideas in the third year makes sense as the students are more experienced readers and appear less likely to form incorrect ideas - even when reading texts on unfamiliar topics. The finding that students reduced the number of local ideas but increased the number of global ideas with experience suggests the students were becoming more adept at linking different text segments rather than capturing local text details when writing summaries of the unfamiliar content. Although the same trend of increasing global ideas and decreasing local ideas as a function of study experience was found with familiar texts, the interaction was not significant. Voss & Silfies (1996) and McNamara Kintsch, Songer & Kintsch (1996) outlined how prior knowledge affects the type of representation constructed while reading. Voss & Silfies argue that when the need for prior knowledge is reduced (e.g. when reading an expanded text which explains the causal relations between events) textbase representations are more likely to be constructed. But when the need for prior knowledge is increased (e.g. when reading unexpanded texts which leaves gaps in the text content) the construction of situation models is more likely. Similarly, Kinstch et al claim that more knowledgeable readers benefit from reading less coherent texts as this encourages them to "fill in the coherence gaps" with their knowledge and thus construct situation models. In contrast, less knowledgeable readers benefit from reading more coherent texts as they lack the knowledge to fill in the coherence gaps. The main point of these 2 studies is that the unexpanded (Voss & Silfies) and less coherent (Kintsch et al.) texts stimulate engagement and active processing. In terms of the present study, perhaps the students became more adept at using their enriched knowledge base to "fill in knowledge gaps" as they became more experienced at reading expository texts. That is, even though the learners lack prior knowledge on the topic of the unfamiliar texts, they may use the knowledge they have gained from 3 years of study to try and fill in knowledge gaps to make sense of the text. This process of filling in knowledge gaps may have engaged the students and led them to actively process the unfamiliar content more deeply; and this active processing may explain the increased number of global ideas and decreased number of local ideas when writing summaries as a function of study experience. Although there is not enough evidence to make such a claim in the present study, this tentative suggestion would make an interesting future study as there has been very little research on text representations as a function of study experience to date.

6.9 Prior knowledge, textbase and inference questions The predictions for the test questions were that good learners would answer more prior knowledge questions correctly because they would have more - or better organised - prior knowledge. This prediction was not upheld. Good learners were also expected to answer more inference questions correctly because they would actively integrate the content of the text when forming text representations. This prediction was partially supported as this was observed with unfamiliar but not with familiar texts. Both good and poor learners were expected to answer textbase questions without too much difficulty as this entailed remembering only the details of the text. This expectation was confirmed as both groups had higher scores on text base than inference or prior knowledge questions and also spent the least amount of time answering textbase questions.

Separate analysis of the **unfamiliar texts** revealed good learners answered more inference questions correctly than poor learners which suggests they were more proficient at integrating the unfamiliar text content.. Good learners also answered more textbase questions correctly than poor learners which suggests they were more proficient at remembering the details of the text. One unexpected finding was that poor learners answered more prior knowledge questions correctly - even though these questions concerned unfamiliar material. One explanation is that the good learners were more reluctant to write answers that they were unsure of while poor learners were more amenable to writing any answer - even if they felt that an answer was not correct. If this was the case poor learners may answer more questions correctly by chance. Alternatively poor learners may have more prior knowledge of the unfamiliar topics. However, if this is the case, then they failed to utilise that knowledge when answering the inference and textbase questions after reading the texts.

With the unfamiliar texts both groups answered fewer prior knowledge questions correctly than textbase or inference questions. This was expected as both groups should have little prior knowledge of topics which are unfamiliar to them. Good learners answered more inference than textbase questions correctly. This suggests that the good learners were integrating different segments of the text when reading and therefore found it easier to recall integrated segments of text than isolated details. This implies situation models are being constructed rather than textbase representations. In contrast, poor learners answered more textbase questions than inference questions correctly which suggests they focused on the details of the text and therefore found it easier to remember isolated details than integrated ideas. This implies textbase representations are being constructed rather than situation models. Integrating information from different sentences in the text requires more active inferencing than remembering text details - particularly when the text is on an unfamiliar topic. Inference questions require the linking of two or more sentences in the text to answer the question, and "*inferring unstated relations between sentences is a process that relies on the situation model*". In contrast, textbase questions require "*only a single sentence from the text to be answered, thus understanding the relation between two sentences or the text as a whole is not necessary.*" (McNamara, Kintsch, Songer & Kintsch; 1996, p 19). McNamara et al propose that text-base measures tap superficial understanding while situation model measures tap into learning processes. In terms of the present study it seems likely that good learners constructed a situation model of the unfamiliar text through active inferencing while poor learners focused on the details of the text and remembering these details. The finding that good learners spent longer answering the unfamiliar test questions while poor learners spent longer answering the familiar test questions may support this conclusion. It seems reasonable that more time will be needed to recall a situation model and locate the targeted information, than it will to recall isolated details encoded in a textbase representation.

Analysis of the **familiar** texts found no main effect of group (good vs. poor), no main effect of type of question, and no significant interaction. When familiar and unfamiliar texts were analysed together, the only significant finding was that fewer prior knowledge questions were answered correctly with unfamiliar than familiar texts. The number of textbase and inference questions answered correctly were very similar for familiar and unfamiliar texts.

Taken together, the findings suggest that the characteristics of prior knowledge, representation and inference can distinguish good from poor learners. When reading *familiar texts* good learners, compared to poor learners made more inferences which reflects the facilitative effects of prior knowledge (McNamara et al, 1996). When reading *unfamiliar texts* good learners became more competent at using low-level strategies to overcome comprehension failure. This behaviour is said to be more characteristic of expert than novice readers (Bereiter & Bird, 1985). When *writing summaries* after reading, good learners produced more local and global ideas which suggests they formed well-structured representations and integrated different segments of text when reading. This contrasts poor learners who produced more incorrect and general ideas which implies they failed to construct adequate representations of the situation described in the text. Also, with *test questions* on unfamiliar text content good learners answered more inference than textbase questions correctly which implies they constructed situation models to infer unstated relations (McNamara et al, 1996). This contrasts poor learners who answered more textbase than inference questions which implies they focused on remembering the textual details.

CHAPTER 7

Final Discussion

7.1 Aims The main aim of this thesis was to identify characteristics that distinguish good from poor learners. This was achieved by investigating characteristics that have been found to play a vital role in learning: namely the strategies used when reading; metacognitive knowledge; motivation; and text representation, prior knowledge and inferencing.

7.2 Strategy Use Chapter 2 investigated whether strategy use could distinguish good from poor learners. Strategy use was identified in a verbal protocols experiment where learners thought aloud their thoughts while reading expository texts. The strategies were identified from the resulting verbal protocols. Good and poor learners were identified from their final exam scores. The predictions were that good learners would outperform poor learners with the number (Loranger, 1994) and the range of different strategies (Baker, 1985) used; and the number of inferences made (Tardieu, Ehrlich & Gyselinck, 1992). These predictions were upheld. Good learners were also expected to self-regulate their reading more effectively by using strategies to overcome comprehension failure (Fischer & Mandl, 1984). This prediction was supported as good learners used more low-level strategies to overcome comprehension failure when reading unfamiliar texts in their second - and probably third year. In contrast, the prediction that good learners would monitor their comprehension more often than poor learners was not supported. Taken together these findings imply that the good learners are outperforming poor learners on several measures and becoming more competent at self-regulating their reading as they became more experienced.

In terms of text familiarity, strategy use was expected to be more frequent with unfamiliar texts because comprehension problems are more likely to occur when readers have insufficient background knowledge (Bereiter & Bird, 1985). In contrast monitoring was expected to be more frequent with familiar texts because reading is accomplished with greater ease and automaticity which frees up working memory capacity for monitoring activities (Gaultney, 1995). Although no main effect of text familiarity was found with strategy use, good learners did use the low-level strategies of re-reading and identifying unfamiliar terms more frequently when reading the second and possibly third year unfamiliar texts. The prediction in terms of monitoring was not supported: in fact, the reverse was found as monitoring was greater with unfamiliar than familiar texts. However, most monitoring consisted of very general comments about a lack of understanding - so it's not surprising that this type of monitoring was greater with unfamiliar texts. These findings support Bereiter & Bird's (1985) conclusion that expert readers are more likely than novice readers to re-read the text and identify problems in an attempt to overcome comprehension failure. Text familiarity was also expected to facilitate the generation of inferences as specific knowledge about the topic of the text should allow learners to construct text representations which go beyond the information given in the text; these representations are "*the by-product of inferences as well as the source for making new inferences, especially elaborative inferences*". (Tardieu, Ehrlich & Gyselinck, 1992). This prediction was also supported.

In terms of study experience, evidence from longitudinal studies (e.g. Goldston, Zimmerman, Seni & Gadzella, 1977; Seni, Gadzella & Goldston, 1978; Watkins & Hattie, 1981; Bartling, 1988) suggest that an increase in study experience is accompanied by a decrease in the use of study habits (i.e. low level strategies) and an increase in the use of deep approaches to study (i.e. high level strategies). No evidence of this trend was found in the verbal protocol experiment which suggests a qualitative change in strategy use did not take place. However, as the students became more experienced: they used a greater range of different strategies and made more inferences. The students also used a greater number of strategies although the difference was not significant. Comprehension monitoring increased significantly with study experience, as did attempts to overcome comprehension failure when reading unfamiliar material. Exactly what underlies this increase in competence with study experience is not clear. Recall from the literature review (section 1.4) that Watkins & Hattie (1981) suggest the qualitative change in strategic behaviour may arise from an increased exposure to different styles of study as students attend courses at different departments with different lecturers. Another possibility is that assignments and tests require more sophisticated arguments and the critical evaluation of ideas as students become more experienced. However, all of the longitudinal studies shown above used *reported* rather than observed measures of strategy use. Therefore, the qualitative change in strategic behaviour may be perceived rather than genuine. The problems of using reported rather than observed measures of strategy use will be considered in more detail shortly.

The main question arising from the verbal protocols experiment is whether strategy use distinguishes good from poor learners. The findings showed that good learners did outperform poor learners with the **number** and **range** of different strategies used when reading. Using a greater range of different strategies implies that the good learners were more *flexible strategy users.* Hartley (1998) defines flexibility as "*the capacity to generate responses, to invent new ones, to explore and expand ideas*" (Hartley, 1998, p42).

Good learners also appeared to *construct richer representations* when reading as they made more inferences and linked different sentences together when writing main ideas in the summaries. Furthermore, good learners seemed to become more *metacognitively aware* as self-regulation appeared to improve with experience. The only aspect of strategy use that did not distinguish good from poor learners was the hypothesised qualitative change in strategy use (e.g. Watkins & Hattie, 1981). However, previous evidence for this trend was based on *perceptions* of strategy use, and these perceptions were not validated. To redress this problem the learners' *perceptions of strategy use* were investigated in chapter 4, and the question of interest was whether a perceived qualitative change in strategy use exists.

These findings suggest that **metacognition** and **prior knowledge** play some role in this increase in competence with study experience. Current thinking into learning emphasises the **interactive** nature of learning. Pressley and his colleagues have focused on the information processing components of **strategies**, **metacognition**, **prior knowledge** and **motivation**. For example, Pressley, Borkowski & Schneider (1989) developed a "good information processor model" which specifies the characteristics of competent thinkers. Good information processors: used strategies for academic tasks; knew how and when to use strategies; and could articulate strategy use with non-strategic knowledge. Pressley, El-Dinary, Gaskins, Schuder, Bergman, Almasi and Brown (1992) focused on the interactions between strategies, metacognition, knowledge and motivation - and stress that strategies are best acquired when teaching promotes all of these information processing components. The remaining chapters in this thesis try to establish whether motivation, metacognition and prior knowledge can discriminate good from poor learners. Chapters 3, 4 and 5 investigate the effects of motivation and metacognition. Chapter 3 investigates different aspects of motivation with the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia & McKeachie, 1990). Chapter 4 investigates explicit metacognitive knowledge of strategies with students' reporting how frequently they use reading strategies. Chapter 5 investigates the relationship between *awareness* of strategies and the *use* of strategies by comparing reported measures of strategy use (obtained in chapter 4) with observed measures of strategy use (obtained in the verbal protocols experiment in chapter 2).

Finally, chapter 6 investigates whether text representation, prior knowledge and inferencing can distinguish good from poor learners. This was achieved in three ways. First, the effect of text familiarity on strategy use and inferencing was investigated in the verbal protocols experiment. Second, text representation was investigated with written summaries of main points in the verbal protocols experiment. Third, prior knowledge and memory for text were investigated more directly in the students' final year with specifically designed test questions.

7.3 Effects of motivation and metacognition on learning

Current views of learning see students as responsible for their own learning - the outcomes of learning being mostly determined by the students' efforts. One explanation for the good learners' superior performance in their final exams and also in the verbal protocols experiment is that they were more **motivated** to perform well. However, as well as being motivated learners "*must also have the skills and abilities to actively engage motivational and metacognitive strategies*" (McCombs, 1988). Motivation is concerned with the reasons - or motives - that drive the students to learn. Metacognition is concerned with the ability to reflect on one's performance - and from this self-reflection - decide what strategies are appropriate. As outlined in the literature review, metacognition has two components: explicit metacognitive knowledge of strategies and the self-control of strategy use. The former refers to one's awareness of strategies and the latter refers to the ability to control or modify strategy use. Motivation and metacognition are inextricably linked. Being motivated but not having explicit metacognitive knowledge of strategies will be unproductive because the students are prepared to expend effort when reading, but won't know what strategies to use. Similarly, having explicit metacognitive knowledge of strategies but not having the motivation to use them will be unproductive because the students know what strategies to use, but aren't prepared to expend the effort needed to use them. Two central questions are investigated in chapters 3 and 4. First, whether motivation discriminates good from poor learners; and second, whether metacognitive knowledge discriminates good from poor learners. Good learners are expected to outperform poor learners with measures of both of these characteristics.

7.4 Motivation The rationale for the claim that motivation facilitates learning stems from findings that well motivated students tend to have a greater incentive to work hard; to be more self-disciplined; and to manage their workload more efficiently compared to poorly motivated students (e.g. Weinstein, 1987). To investigate whether motivation increased with study experience the students' reported ratings of motivation from the Learning and Study Strategies Inventory (LASSI) were compared in the first, second and third years. Analysis found no difference between good and poor learners, but a possible drop motivation may have occured in the second year of study. Anecdotal comments from students' during a debriefing session held after the second year verbal protocols experiment suggest this drop in motivation could be due to increasing internal and external distractions. Although they appear highly motivated, some students seem to find it difficult to enact their intentions with so many competing demands placed on their time. Other students expressed a lack of goal direction, sometimes caused by the realisation that initial goals were no longer a viable option. Some students appeared to adopt failure avoidance goals (Covington & Omelich, 1979) in that they did not put the effort into their study and therefore could attribute failure to a lack of effort rather than to a lack of ability which is damaging to one's self-worth. Although several factors seem to underlie this perceived drop in motivation, the fact remains that many students would benefit from guidance and support during this "mid-study motivational conflict". Rather than wait for students to actively seek help or guidance from tutors, the second year of study should be recognised as potentially difficult for students. Teachers working with second year undergraduates should be aware of this motivational conflict and try to incorporate some motivational support into the curriculum.

Evidence from the LASSI suggests that motivation does not distinguish the good from poor learners in this study. However, the LASSI only gives a general indication of motivation; it does not consider different aspects of motivation. To investigate motivation in more detail the

Motivated Strategies for Learning Questionnaire, or MSLQ (Pintrich, Smith, Garcia & McKeachie, 1991) was given to the students in their final year. Pintrich and his colleagues investigated how different components of motivation influence academic achievement. Their general-expectancy-value model of motivation shows that **goal orientation** (Harter, 1985) and **task value** (Eccles, 1983) can facilitate academic performance. Students with intrinsic goal orientation and high task value are more likely to achieve academic success that students with extrinsic goal orientation and low task value. Their model also shows how student efficacy, control and outcome beliefs, test anxiety and expectancy for success interact and affect academic performance. With **efficacy beliefs**, students who attribute success to ability rather than effort; and who attribute success to internal rather than external factors (Weiner, 1986) are more likely to achieve academic success. The relationship between **control beliefs** and academic performance is less clear cut as associations between internal control beliefs and achievement have been found with adolescents, but not with younger children or older university students (Findley & Cooper, 1983). **Test anxiety** was also found to be closely linked to **expectancy for success**, as high levels of test anxiety are associated with low expectations for future success (Tobias, 1985). Put simply the more students worry about tests and exams the greater their expectations for failure.

In this present study only goal orientation and task value distinguished good from poor learners. Good learners reported being *intrinsically motivated* and having *high task value*, while poor learners reported being *extrinsically motivated* and having *low task value*. Taken together, the findings suggest that good learners are more motivated by intrinsically oriented goals such as mastery, challenge or learning; and view tasks as challenging, capable of fulfilling their achievement needs and confirming their competence. In contrast, poor learners appear to be motivated by extrinsically oriented goals such as getting good grades, rewards or approval from others; they are also less likely to view tasks as challenging or enjoyable, or a way of mastering new learning skills. This portrait of intrinsic motivation is eloquently described by McKeachie, Pintrich, Lin, Smith & Sharma (1990):

> *"Humans have a need to seek optimal levels of stimulation and sense of competence. By implication, it also suggests that the environment must provide learners with appropriate opportunities and resources for such activities. Our conceptualization of an intrinsic motivation to learn indicates that the individual comes to posses 'personal responsibility factors'. These capacities enable the individual effectively to pursue involvement with intrinsically interesting education tasks."* (p67).

In terms of the other components on the MSLQ (i.e. efficacy, control and outcome beliefs, test anxiety, expectancy for success, and the use of cognitive and resource management strategies) no between groups differences were found. These findings contrast those of Pintrich & Schrauben (1992) who found that learners with intrinsic orientation goals and high task value tended to have high self-efficacy for learning beliefs; and were also more likely to be cognitively engaged in learning through using cognitive and metacognitive learning strategies.

Why good and poor learners did not differ in terms of these motivation components is unclear. One explanation is that the effects of efficacy beliefs, control beliefs and expectancy for success are mediated by other factors and therefore difficult to tease apart. With efficacy beliefs, students may believe that they can perform well in exams but also believe that the exam questions are arbitrarily marked. Thus efficacy beliefs may be mediated by perceptions of task difficulty. With control beliefs, recent evidence suggests that volition, or '*purposively expending effort in an intentional manner*" plays a vital role. For example, students who believe they have control over their learning - but also act with *volition* perform better than students who believe they have control over their learning but lack volition (Corno, 1986). Thus volition appears to mediate the effects of control beliefs on achievement.

With test anxiety, a negative association was predicted between anxiety and expectancy for success. This was found with both good and poor learners which suggests anxious students have lower expectations for success. However, no similar negative association between anxiety and exam performance was found. This implies that the students found ways to counteract anxiety, such as working on their test taking skills which would allow the students to deal more effectively with intruding anxious thoughts (Tobias, 1885).

Finally, good and poor learners did not differ in their reported use of cognitive, metacognitive and resource management strategies. However, the MSLQ measures reported strategy use and therefore reflects perceptions of strategy use. This problem was encountered in the verbal protocols experiment where exam performance was found to be better than reported ratings of learning (from the LASSI) at detecting between groups differences. Exam performance captured differences in the way that good and poor learners: used strategies; used strategies to overcome comprehension failure as they became more experienced; and generated inferences. Self-reported measures (from the LASSI) were only capable of capturing general patterns of reading behaviour that seemed characteristic of all learners (i.e. most students made more inferences when reading familiar than unfamiliar texts). One explanation for the greater sensitivity of exam scores over reported measures was that reported measures may simply reflect feedback on previous exam performances rather than actual study habits (Bartling, 1988). Recall from chapter 2 that Bartling found postdictive validities correlated significantly with exam scores while predictive validities did not. This finding was also replicated with the reported LASSI ratings. This implies that students may eventually come to evaluate their study habits solely in terms of feedback on how they perform in exams.

Although feedback can enhance motivation and learning, it can also hinder it. Early investigations suggested that *informational feedback* rather than *controlling feedback* promoted intrinsic motivation. That is, information providing effective feedback in a setting with choice or autonomy will enhance intrinsic engagement with a task; but information that fosters pressure to perform or think in a predetermined way will facilitate extrinsic goals (Deci, 1975). More recently, Schmidt & Bjork (1992) investigated how learning could be optimised in real-world settings. They found that giving frequent feedback during training can enhance performance while training; but can also degrade longer-term learning. One explanation for this is that frequent feedback may hinder the use of error detecting skills that enhance long term learning. Thus both the **type** and the **frequency** of feedback can enhance or hinder a student's motivation to learn and the effectiveness of their learning. McKeachie, Pintrich, Lin, Smith & Sharma (1990) stress that feedback should be informative in pinpointing the source of errors; and encouraging. Feedback should also be based on performance measures that the students respect rather than measures they feel are subjective or inconsistent.

Taken together, evidence from the MSLQ ratings suggests that intrinsic goal orientation and task value are the motivation components that best discriminate good from poor learners; and are thus the motivation components most associated with exam success. The next logical step should be to determine how these aspects of motivation can be developed and encouraged in poor learners. This task is not simple, as students can adopt different goals with different tasks and also hold different goals with the same task. For example, students may adopt learning goals when they want to master a task or improve their personal performance; but adopt performance goals when they want to perform well in relation to others (Dweck & Elliot, 1983). Furthermore, a student may want to become a teacher because of the intrinsic goal of working with other people, but also because of the extrinsic goal of gaining approval from family and friends (Schultz, 1994). Probably the most important influence on whether a student is intrinsically or extrinsically motivated is the teacher. Teachers can support and enhance a student's determination to learn by providing stimulating and challenging tasks and by encouraging the students to learn for the rewards of mastery, challenge and fulfilment. McKeachie (1986) captures how the attitudes and enthusiasm of a teacher can greatly influence a student's intrinsic motivation to learn.

> *"Research on student ratings of teaching as well as on student learning indicates that the enthusiasm of the lecturer is an important factor in affecting student learning and motivation. Not only is the lecturer a model in terms of motivation and curiosity, the lecturer also models ways of approaching problems, portraying a scholar in action in ways that are difficult for other media or methods of instruction to achieve".*

However, there is no simple procedure for promoting intrinsic motivation. A teacher needs to develop flexibility to juggle the needs of the students, the dynamics between the group of students, the demands of assessment, and the resources available. One final comment should be made on the very low reported frequencies of peer learning and help seeking. Both groups reported using these strategies much less frequently than any other. This suggests that the students are either unaware of the potential benefits of these strategies; or they are aware of the strategies but reluctant to use them. This highlights the problem of a lack of metacognitive knowledge of strategies; before students can use strategies they must be aware of them.

Explicit metacognitive knowledge could therefore, be one of the characteristics that distinguishes the good from poor learners in this study. This possibility is now considered.

7.5 Explicit metacognitive knowledge of strategies Metacognition plays a vital role in learning and is defined as a person's cognition about cognition; that is, a person's knowledge of their cognitive processes and states of memory such as attention, or knowledge of strategies. As stated earlier there are two components to metacognition: **metacognitive knowledge** (e.g. knowledge of strategies); and **self-regulation** (e.g. the control of strategy use). In chapter 4 explicit metacognitive knowledge of strategies was investigated with a questionnaire on reading strategy use; while the self-regulation of strategy use was investigated in the verbal protocols experiment.

Evidence suggests that students with metacognitive knowledge of strategies tend to be better readers. Spring (1985) found that good readers reported using comprehension strategies more frequently than poor readers, although both groups reported using study strategies equally often. Fischer & Mandl (1984) and Forrest-Pressley & Waller (1984) both found that better readers could report the strategies they use to overcome comprehension failure while poorer readers could not. These findings suggest that reading ability is associated with a greater awareness of strategies; or more specifically, a greater ability to report the strategies one uses. In terms of this thesis the point of interest is whether metacognitive knowledge can distinguish the good from poor learners. If confirmed, this suggests that metacognitive knowledge may facilitate exam success; and also the better performance of good learners in the verbal protocols experiment. Explicit metacognitive knowledge of strategies was investigated with a modified version of Spring's reading strategies questionnaire. Students reported how frequently they used different reading strategies and cluster analysis was performed on the ratings. Three clusters of reading strategies were identified.

The strategies in cluster 1 were **low-level strategies** which facilitate memorisation rather than understanding (i.e. underline, re-read and notes). Some of these strategies (i.e. summary, note important points, link text to knowledge, and define unfamiliar terms) could support a deeper understanding if the reader actively incorporated the new material into their knowledge base; and also updated and revised prior knowledge in light of the new material (Stevenson & Palmer, 1994). Spring found that good and poor readers reported using low-level study strategies with equal frequency and concluded these strategies did not distinguish good from poor readers. However this finding was not replicated in this study. Good learners reported using these strategies more frequently than poor learners which implies that a greater metacognitive awareness of *low-level* strategies may distinguish good from poor learners. Also, as both groups reported using these strategies more often than the others, this suggests that the students' rely heavily on strategies that are more likely to aid memorisation than understanding.

The strategies linked in cluster 2 were all **high-level strategies** which enhance understanding rather than memorisation. These strategies: facilitate monitoring and make the reader aware of any comprehension problems (i.e. monitor comprehension, identifying unfamiliar terms and ask questions); help the reader to impose structure and transform the material into a more meaningful form (look for logical relations, relate different parts of the text, restate and outline); and help the reader engage with the text (thinking of possible uses for the material). Spring found good readers reported using high-level understanding strategies more often than poor readers and concluded that it was primarily high-level comprehension strategies that discriminated good from poor readers. In this present study good and poor learners reported using these high-level strategies with equal frequency so they do not appear to distinguish good from poor learners.

The strategies linked in cluster 3 reflect **critical thinking** as the readers evaluate the text in light of their own experiences and beliefs, and react to the text in a subjective manner (i.e. link text to emotions, to beliefs and to experiences; predict content, challenge the author and draw diagrams). Spring found that both good and poor readers reported using these strategies infrequently and this finding was replicated in the present study. The ability to think critically seems under-developed - even at an undergraduate level (Chall, 1983). This is probably because critical thinking was not encouraged or expected when the students were younger. Currently, primary schools in England have a structured program to teach literacy skills for one hour each day. Part of this time is spent teaching the children to engage with the text when reading and react critically to the content. In short, the children are being encouraged to develop critical thinking skills. Fitzpatrick (1994) stresses the need to teach students to think critically through techniques such as co-operative learning. Ratings from the MSLQ found peer learning was rarely reported by the students in this study. Further investigation is needed to find out whether students are unaware of the benefits of working collaboratively, or whether they just don't like working collaboratively. Instruction in the use of these critical thinking skills is vital. Students need the *declarative knowledge* of what these strategies are and why they should be learned; the *procedural knowledge* of how to use them; and the *conditional knowledge* of evaluating the effectiveness of critical thinking strategies.

The findings also imply a *perceived qualitative change in strategy use* (e.g. Watkins & Hattie, 1981) with good but not poor learners. Good learners' frequency reports of high-level strategies increased with experience, but their frequency reports of low-level study strategies reduced in their final year. This implies that good learners in their final year of study were more likely to use strategies which enhance understanding and less likely to use strategies which enhance remembering. In contrast, poor learners' frequency reports of both high-level and low-level strategies decreased in the second year. This perception of less frequent strategy use by poor learners may be linked to the possible drop in motivation of good and poor learners in the second year of study. If so, this implies that poor learners find it more difficult to use strategies when they lack the motivation to use them - but that good learners can use strategies despite their decreased motivation.

These findings also stress the need to teach learners how to think critically; both good and poor learners seems to lack the declarative knowledge of what these strategies are, as well as the procedural knowledge of how to use them. It is important to stress that the investigation of metacognitive knowledge reflects *perceived* strategy use rather than actual strategy use. The findings from chapter 4 showed that good learners *report* using high-level strategies more frequently as they gain more experience but they may not actually *use* them more frequently when observed. In fact, observed strategy use in the verbal protocols experiment found no evidence of a qualitative change in strategy use with the good learners. This equivocal finding is explored further in chapter 5, when reported strategy use (from the reading strategies questionnaire) is compared with observed strategy use (from the verbal protocols experiment). Before evaluating this comparison, the second component of metacognition is considered; the self-control of strategy use.

7.6 Self-regulation of strategy use Explicit metacognitive knowledge of strategies seems necessary for strategy use, but it is not enough for successful learning. Students also need to self-regulate their performance by monitoring comprehension and responding to comprehension failure by using fix-up strategies. Early evidence indicated that good readers were more likely to self-regulate their reading and employ comprehension strategies when faced with comprehension failure (Fischer & Mandl, 1984; Kletzein, 1988). However, these studies often used the error detection paradigm and the validity of this procedure has been criticised. Failure to detect an error may not be due to inadequate monitoring, but to other factors such as a belief that printed text could not contain errors (Winograd & Johnson, 1982). More recent evidence suggests that simply reading texts may not yield sufficient metacognitive information for self-regulation (Pressley & Ghatala, 1990). Although the evidence for self-regulation is not conclusive, my tentative prediction is that good learners will use strategies to overcome comprehension failure while poor learners are more likely to give up. Thus self-regulation is predicted be one of the characteristics that distinguishes the good from poor learners.

Evidence from the verbal protocols experiment suggests good students became more competent at self-regulation as they gained more experience. Although the comprehension monitoring of both groups increased with study experience, an increase in the use of low-level strategies to overcome comprehension failure was only found with good learners when reading unfamiliar texts in their second and probably third of study. Good learners used the re-reading strategy and identified unfamiliar terms more frequently to overcome their comprehension failure. Taken together the findings generally support Bereiter & Birds (1985) conclusion; that expert readers are more likely than novice readers to employ re-reading and identify problems to overcome comprehension failure. This suggests that self-regulation does distinguish good from poor learners - but only after they have gained some experience as undergraduates.

7.7 Reported vs. observed strategy use The main reason for comparing reported strategy use with observed strategy use is to see whether students actually use the strategies they say they use. In this thesis reported strategy use was identified when students said they used this strategy frequently when completing the reading strategies questionnaire (described in chapter 4); while observed strategy use was identified when the students actually used strategies in the verbal protocols experiment (described in chapter 2).

Evidence from comparative studies of self-report versus observed measures of strategy use with children is equivocal. Cavanaugh & Borkowski (1980) found that the amount of knowledge children had about strategies did not distinguish those who used them from those who did not; and that good verbalizable memory was not associated with successful memory performance. Waters (1982) however, found a link between metamemory and performance; and between strategy use and performance with adolescents. Students with knowledge that elaboration was better than non-elaborative study strategies; and students who used elaboration frequently had more successful memory performances.

Evidence from comparative studies of university students is also equivocal. Phifer & Glover (1982) found that students identified as high-comprehenders underlined more main ideas when reading and recalled more information after reading. However, no differences between high and low comprehenders were found with reported strategy use. Thus "*students did not consistently apply the metacognitive and cognitive strategies they professed to use, or they were not proficient in applying them*" (Phifer & Glover, p194). In contrast, Alexander (1986) found that undergraduates who said they underlined when reading did use this strategy when reading, while those who said they did not underline did not use this strategy when reading.

Taken together the findings suggest that the students have some metacognitive knowledge of what the strategies are, but fail to act on this knowledge when observed. Perhaps consistency is more likely to be found with low-level than high-level strategies because students are more likely to have explicit metacognitive knowledge of low-level than high-level strategies. For example, students are more likely to have the declarative knowledge that re-reading can overcome comprehension failure (Baker & Anderson, 1982); and have procedural knowledge of how to use the re-reading strategy, such as using key words to identify what needs to be re-read to overcome comprehension failure (Garner, 1990). With high-level strategies such as monitoring, students are less likely to have the declarative knowledge of what these strategies are as well as the procedural knowledge of how to use them. Alternatively, students may know about high-level strategies, but be unable to use them because they don't know how to, or because too much effort is required.

Furthermore, low-level strategies require less effort than high-level strategies so the motivation to use these strategies become less critical. In contrast, with high level reading strategies such as monitoring comprehension, students are less likely to have the declarative knowledge that these strategies can enhance comprehension, as well as the procedural knowledge of how to use them.

If consistency between reported and observed strategy use is determined by the amount of metacognitive knowledge about strategies, then consistency between reported and observed use should be high with low-level strategies when students are more likely to have metacognitive knowledge; and low with high-level strategies when students are less likely to have metacognitive knowledge. High consistency would also be predicted with critical thinking strategies as students are less likely to have metacognitive knowledge of these strategies and are also less likely to use them. In general, the findings support this argument, although support was strongest for good learners rather than poor learners, and strongest with some strategies (e.g. critical thinking strategies) rather than others (e.g. taking notes).

The highest level of consistency was found with good learners and the low-level re-reading strategy; almost 70% of good learners reported re-reading frequently and also used this strategy when observed. In contrast, although 60% of poor learners reported re-reading, only 33% actually re-read the text when observed. Some consistency was also found with the strategies of restatement and linking text to prior knowledge; but this was characteristic of a small number of learners. At best, one-third of good learners and one-quarter of poor learners both reported and used these strategies. However, this contrasts the finding in the verbal protocols experiment as these strategies were used by most students, and were also used more frequently than any other strategy. One problem with the reading strategies questionnaire is that it doesn't consider the effects of text familiarity, topic familiarity and the nature of the task on strategy use (Thomas & Rohwer, 1985). How often students use strategies will depend upon what topic they are reading and how familiar it is. These findings suggest that many students may lack the declarative knowledge of what this strategy is and how it can facilitate understanding, as well as the procedural knowledge of how to use it. This possibility warrants further investigation because the students need to develop an awareness of the benefits of these strategies as well as the procedural knowledge of how to use them effectively.

Both groups have optimistic perceptions of how often they used the memorisation strategies of taking notes, underlining, identifying important points, summarising and defining unfamiliar terms. Why these strategies were not used when the students said they used them frequently is unclear. There are several explanations. The students may not use them as often as they think they do. To investigate this possibility some verification is needed, perhaps by comparing process measures with product measures. For example, by comparing the strategies used when reading aloud (i.e. a measure of strategy use during the process of reading) with the strategies used when writing summaries (i.e. a measure of the product of comprehension). Although the students were asked to write a summary of the main points after reading, they were used to investigate the type of representation constructed during reading rather a verification of the strategies used when reading. Another explanation is that the confines of the experimental setting may have constrained the way the students read the texts. The strategies the students use in a laboratory setting may be different to the strategies they use when reading in the library or in their own college rooms.

A low-level of consistency was expected with the high-level understanding strategies as reported and observed use were both predicted to be low. This prediction was supported with most of the understanding strategies; although monitoring comprehension and identifying unfamiliar terms were used a little more often than the other strategies. Poor learners over-estimated their use of identifying unfamiliar terms in the first year, but 25% reported and used this strategy in their final year. In contrast, good learners over-estimated their use of this strategy in all 3 years of study. With monitoring comprehension, awareness matched production with both good and poor learners, but at best only 30% of good and 17% of poor learners reported and used this strategy. Taken together, the findings show that very few students actually used these strategies when reading and only slightly more reported using them often.

The prediction of high consistency between reported and observed use of critical thinking strategies was supported. It seems that both good and poor learners are unaware that critical thinking strategies can enhance understanding and also lack the procedural knowledge of how to use them. One explanation is that the students have failed to reach the highest stage of reading which requires students to read more difficult materials, read beyond their immediate needs and also integrate different sources on knowledge and different points of view (Chall, 1983). As stated earlier, the failure to use these strategies may arise because these skills are not encouraged and developed in earlier school years (Fitzpatrick, 1994).

The overall picture emerging from the study of reported and observed strategy use is despairingly similar to that described by Simpson (1984) and Brennan, Winograd, Bridge and Hiebert (1986). Students appear to rely heavily on low-level strategies such as re-reading and fail to use high level strategies such as monitoring or critical thinking strategies. In terms of the students in this study, they appear overly optimistic about their use of low-level memorisation strategies. This implies they have some surface understanding of what they should be doing; but need help to enact this knowledge. In contrast, the students are accurately pessimistic about their use of high-level critical thinking strategies which implies they don't know what these strategies are and don't know how to use them. Even taking into account the limitations imposed on this study from the artificial laboratory environment, this worrying picture of ill-prepared undergraduates being exposed to the demands of independent study is being increasingly acknowledged by educational researchers. Students need help in enacting the metacognitive knowledge they have, and help in acquiring and enacting the metacognitive knowledge they lack.

7.8 Representation, prior knowledge and inference The final characteristics investigated in this thesis were representation, prior knowledge and inference. The main question of interest was whether these characteristics could discriminate the good from poor learners in this study. Evidence has shown that prior knowledge facilitates the generation of inferences when reading (Kintsch, Welsh, Schmalhofer & Zimny, 1990; Recht & Leslie, 1988). This finding was supported in the verbal protocols experiment (chapter 2) as both groups made more inferences when reading familiar texts, but made more unwarranted inferences when reading unfamiliar texts. This shows that prior knowledge not only facilitates inferencing, but also provides a richer set of constraints which constrain the generation of implausible inferences. Recht & Leslie found that prior knowledge enhanced the ability of both good and poor readers to identify main points when reading. This suggests prior knowledge compensates for learning ability. However, in the verbal protocols experiment good learners made more inferences than poor learners. This suggests prior knowledge can also discriminate students, when learning ability is defined in terms of academic achievement. The question of interest in terms of this thesis is how prior knowledge facilitates learning. One explanation is that prior knowledge facilitates the construction of text representations during the reading process.

Evidence has shown that prior knowledge can affect the type of representation constructed during reading (Voss & Silfies, 1996). Kintsch's (1988; 1994) model of reading comprehension explains how this may occur. To recap briefly, Kintsch describes 3 types of representation constructed when reading: a surface representation; a textbase representation and a situation model. At a surface level the words and relations between the words are encoded; at a textbase level the semantic and rhetorical structure are encoded; and the situation model elaborates and integrates the information in the text with prior knowledge. A textbase representation is sufficient for remembering text and is adequate to summarise and recall a text; but understanding will be superficial. A deeper understanding is gained from the construction of a situation model through the process of elaborating and integrating text with prior knowledge.

Based on this evidence, the good learners in this study should be more likely to construct a situation model of the text because they are more likely have a better knowledge of the topic of the text. This assumption was investigated with summaries of the main ideas written after the students had read the texts. The ideas were categorised as global (link information from different sentences); local (information from one sentence); incorrect; general (non-textual information); and topic (refers to the topic of the text). Analysis found that local and global ideas were more frequent with familiar texts while incorrect ideas were more frequent with unfamiliar texts. This interaction shows the facilitative effects of prior knowledge. With familiar texts the relationships between concepts are familiar and it should be easier to form text representations. In contrast, when reading unfamiliar texts these relationships are unknown and the reader uses the structure of the text to help them develop relationships between the concepts (Roller, 1990). A lack of background knowledge also means there are fewer constraints to temper the number of incorrect ideas.

In terms of differences between the two groups, good learners produced more local and global ideas. This was attributed to the construction of well-formed representations when reading as some inferencing is required to link the semantic information from one sentence to another. Poor learners produced more incorrect and general ideas which suggests they were producing very generalised ideas that were not specifically related to the text content, and producing ideas that were not compatible with the text content. This suggests they failed to construct well-formed representations and therefore misconceived ideas were not corrected.

Commander & Stanwick (1997) claim that successful comprehension monitoring enables successful text representation because inadequate monitoring can hinder processing at the textbase level and prevent the construction of a situation model. So perhaps a failure to monitor text underlies the poor learners' weaker summaries. This explanation is probably flawed because observed differences in monitoring were not found in the verbal protocols experiment. A more likely explanation is that the demands of the task adversely affected the poor learners' written summaries. Recall that students were asked to recall the **main ideas**. If poor learners failed to construct, from their textbase understanding, a representation of the situation described in the text, then they would find it difficult to recall the main points. But if the poor learners tried to summarise the text from their textbase level of understanding, then they would probably find it easier to recall textual details rather the main ideas. An attempt to explore this possibility in more detail was made in the students' final year with questions specifically designed to test the students' representations of the texts.

Test questions were devised and given to the students after they had read the third-year texts. To recap briefly, prior knowledge questions tested the students' prior knowledge of the topic of the text; textbase questions required information that was located in a single sentence; and inference questions required information that was located in two or more sentences. The rationale was that textbase questions "*require only a single sentence from the text to be answered thus understanding the relation between two sentences or the text as a whole is not necessary*". Inference questions however, "*require inferring unstated relations between sentences and is a process that relies on the situation model*". (McNamara, Kintsch, Songer & Kintsch, 1996, p 19).

Good learners were expected to answer more prior knowledge questions because they are more likely to have more - or better organised - prior knowledge of the topic of the text. This prediction was not supported, in fact, poor learners answered more prior knowledge questions on unfamiliar text content than good learners. This was puzzling and did not tie in with earlier findings, such as good learners generating more inferences when reading and also producing more local and global ideas when writing summaries. Both of these findings were attributed to the facilitative effects of the good learners' prior knowledge. If poor learners did have more prior knowledge of the unfamiliar texts, then no facilitative effects were apparent when they answered the textbase and inference questions on the unfamiliar content.

Good students were also expected to answer more inference questions correctly than poor learners because they are more likely to actively integrate ideas in the text and form a situation model of the text content. This prediction were partially supported as good learners answered more inference questions with unfamiliar but not familiar texts. Furthermore, with test questions on the unfamiliar texts, good learners answered more inference than textbase questions while poor learners answered more textbase than inference questions. This suggests that the good learners recalled situation models when answering the questions as they performed best when recalling integrated segments rather than isolated details. In contrast, poor learners seem more likely to recall textbase representations as they performed best when recalling isolated details rather than integrated ideas.

Taken together the evidence suggests that representation, prior knowledge and inference can distinguish good from poor learners. With good learners, the facilitative effects of prior knowledge on strategy use were found with the generation of more inferences when reading. Evidence also suggests that good and poor learners constructed different types of representation when reading; good learners produced more local and global ideas while poor learners produced more incorrect ideas when summarising the main points. Further evidence for the construction of different representation was found in the students final year when reading unfamiliar texts; good learners answered more inference questions which required the construction of a situation model while poor learners answered more textbase questions which required only a textbase understanding.

On the whole I think representation, prior knowledge and inferencing does distinguish the good from poor learners in the present study, but the distinction seems most apparent after the good learners have gained experience (i.e. in their final year) and also when they read unfamiliar texts. One explanation could be that the good learners are becoming more competent at self-regulating their reading and perhaps become more actively engaged with a text when they lack knowledge of the topic. A combination of greater metacognitive control and more engagement and active processing will enhance the representation constructed when reading. Although there is not enough evidence to justify these claims in this thesis, further investigation of text representation as a function of study experience is needed.

Linking the findings across the experiments Two threads run throughout the experiments in this thesis: some characteristics appear to distinguish good from poor learners; while some characteristics seem general to all students. Some overall conclusions about these characteristics are now drawn.

7.9 Characteristics that distinguish good from poor learners From the experiments in this thesis good learners were found to outperform poor learners on a number of measures. This superior performance was attributed to: **better metacognitive knowledge** (as more strategies and a greater range of strategies were used in the verbal protocols experiment); **better metacognitive awareness** (as self-regulation in the verbal protocols experiment improved with experience, and low-level memorisation strategies were reported with greater frequency with the reading strategies questionnaire); **greater motivation** (in terms of reported intrinsic goal orientations and high task value with the MSLQ); **greater prior knowledge** (as more inferences were made in the verbal protocols experiment); **better text representation** (as the ability to recall text details and integrate information was superior when writing summaries and also when answering questions on unfamiliar text content). Thus, students who display these characteristics seem more likely to achieve academic success. However, the good learners' superior performance cannot be attributed to simply greater motivation, metacognition or prior knowledge because the effects of these factors were found to be inextricably linked. The interactions between these components are important, as the practical implications of this research suggests that poor learners need support and encouragement to acquire and develop these characteristics. A greater understanding of how these characteristics interact, and how they enhance performance, will inform how we can support poor learners to acquire and develop these skills.

In terms of **motivation**, only goal orientation and task value distinguished good from poor learners. The perception of being intrinsically motivated by mastery and challenge, and viewing tasks as challenging and fulfilling achievement were the motivation components most associated with academic success. In contrast, the perception of being motivated by getting good grades and viewing tasks as less challenging were associated with poorer academic achievement. The challenge to educators therefore, is to provide a learning environment that fosters intrinsic motivation and high task value. The teacher probably is the most effective person to undertake this task, as "*the attitudes and enthusiasm of the teacher can greatly influence a student's intrinsic motivation to learn*" (McKeachie, 1986). This is a difficult challenge as there is no simple method for promoting intrinsic motivation; the teacher has to constantly juggle the competing demands of the students, assessment, and resources. However, the influence of these components on achievement suggests this task cannot be neglected.

The links between **motivation** and **metacognition** have been well-documented (e.g. Schultz, 1997; Pintrich & Garcia, 1991; Dweck & Leggett, 1988). According to Schultz, *"one's goal orientation may influence the direction of thought and behaviour, the regulation of thought and behaviour, and the level of performance on academic tasks".* Students need the explicit metacognitive knowledge of what strategies are and how to self-regulate their use; but also need the motivation to actually use them. Good learners were found to have explicit metacognitive knowledge of low-level memorisation strategies as they reported using these strategies more often than poor learners. However, although good learners also used a greater number of strategies, as well as a greater range of different strategies when reading; they relied heavily on the low-level strategies of re-reading, restatement and using (but not necessarily updating or evaluating) prior knowledge. Taken together, these findings suggest that good learners have some awareness of low-level strategies, but need to develop the procedural knowledge of how to use them. Alternatively, good learners may be aware of these strategies, and know how to use them, but lack **volition**, i.e. the intention to expend effort to use them (Corno & Rohrkemper, 1986). In contrast, poor learners seem to lack both declarative and procedural knowledge, and need to develop an awareness of what these low-level strategies are, as well as the procedural knowledge of how to use them.

On a more positive note, good learners did self-regulate their reading more effectively as they gained experience which implies they were becoming more competent with this metacognitive skill. Good learners also produced more integrated ideas in their summaries, and answered more questions that required the integration of ideas on an unfamiliar topic. However, even though the good learners produced significantly more integrated ideas in their summaries, the frequency of these ideas was low which implies that the good learners' integrated only a small part of the text when reading. Taken together, the findings suggest that good learners are becoming more competent at self-regulation and text representation. But *"the progression from acclimation to competence and perhaps onto expertise is a time-intensive occurrence"'* (Alexander et al, 1997). The evidence from the experiments in this thesis suggests that good learners were beginning to show signs of progressing from acclimation to competence with self-regulation and text representation. No similar improvement was found with poor learners which suggests they may not have moved on from the acclimation stage.

7.10 Characteristics that are general to all students Although good learners outperformed poor learners with some measures, with other measures the performances of the two groups were very similar. In terms of **motivation**, all students appear to need greater support in their second year of study as both groups reported lower levels of motivation at this time. Anecdotal evidence suggests there are several reasons for this drop in motivation: competing distractions from both within and outside study; a lack of goal direction; and the adoption of failure avoidance goals. Many students appear to lose their direction and flounder at this time.

Further investigation would help us understand why motivation decreases at this time, and whether motivational support during this sensitive period could enhance goal orientation, task value as well as academic achievement.

In terms of **metacognition**, both groups lack the declarative and the procedural knowledge of high-level understanding strategies and critical thinking strategies. All of the students in this study report an over-reliance on a small number of low-level strategies, such as re-reading, which aid memorisation rather than understanding. There is an urgent need to help university students: to develop the metacognitive awareness of what these strategies are and how they can enhance understanding rather than memorisation; to develop the procedural knowledge of how to use them; and to develop the conditional knowledge of how to evaluate the effectiveness of these strategies. This is particularly important with critical thinking strategies as perceptions of infrequent use are supported by observations of infrequent use.

Finally, Alexander, Murphy, Woods, Duhon & Parker (1997); Watkins & Hattie, (1981); Seni, Gadzella & Goldston, (1978);and Zimmerman, Seni & Gadzella, (1977) suggest a qualitative change in strategy results from increasing competence. As experience is gained the use of high-level strategies increases while the use of low-level strategies decreases. Alexander et al suggest that an increase in prior knowledge underlies this increased use of high-level strategies. While no evidence of this qualitative trend was found in this thesis, it is important to stress that the studies outlined above all used *reported* measures of strategy use, therefore the qualitative change in strategy use may be *perceived* rather than genuine. In fact the findings from the verbal protocols experiment and the reading strategies questionnaire suggest this trend is perceived rather than genuine.

7.11 Summary and conclusions Overall, the experiments in this thesis discovered some central findings. In terms of **motivation**, intrinsic goal orientation and high task value seem to characterise good learners; and the challenge to educators is to provide an educational environment where these motivational components are encouraged, particularly amongst those students who may be struggling to achieve. However, many students seem de-motivated in the middle study year - perhaps by a lack of goal direction or difficulty in coping with increasing distractions. With poor learners, this period of de-motivation may be responsible for a decrease in strategy use in the second year - they may lack the *volition* to use strategies when the motivation to use them is lacking. If true, this implies that the second year may be a sensitive period for learning, after which it becomes increasingly difficult for de-motivated students to make up the lost ground. Further investigation could investigate whether support at this difficult time could facilitate intrinsic goal orientation, task value and perhaps even academic achievement.

In terms of **prior knowledge**, an increase in prior knowledge appears to facilitate text representation; but the real danger is that the material students learn has only been superficially understood when first encountered. Students need to appreciate how prior knowledge facilitates understanding and also the different ways that prior knowledge can facilitate understanding (i.e. at a linguistic level such as inferring the referent of a pronoun and at an understanding level such as when evaluating and updating prior knowledge in light of new information).

In terms of **metacognition**, students who perform well academically also become more competent at self-regulation. However, most of the students who took part in these experiments need help to enact the metacognitive knowledge they possess, and to acquire and enact the metacognitive knowledge they lack. In particular, students need to develop both the metacognitive awareness of critical thinking strategies as well as the procedural knowledge of how to use them. This would ultimately help students to construct richer representations when reading and gain a better understanding of the material. Only after this will the acclaimed *perceived* qualitative change in strategy behaviour become genuine.

Throughout this final discussion areas of concern have been identified, such as the apparent drop in motivation in the second year of study; or the poor learners' perceived lack of intrinsic goal orientation. The lecturer has usually been identified as the person ideally suited to provide support and instruction; but, the lecturer alone cannot address all of these concerns. Instructional study skills courses could alleviate some of these concerns. For example, a major source of conflict between educators and students can be the desire for independent learning. It is generally accepted that, by the time students enter higher education, the responsibility for learning becomes their own rather than the lecturer's. For students, this can be a difficult transition to make as they have to make choices that in the past were often made for them. One way to alleviate this conflict is to support the students during this transitionary period by helping them to recognise and develop the skills needed for independent learning. The students need to know what is expected of them; and also need to develop the necessary skills to take the initiative in their study. Study skills courses are now being introduced in many British universities with the aim of providing students with the necessary knowledge and skills to undertake their study commitments with greater awareness and confidence. Evidence from intervention studies has shown that with practice and training students can: make positive gains on reported strategy use (McKeachie et al, 1985, Ickes et al, 1990 - in Table 1.1); have higher pre-test to post-test gains in knowledge and achieve the correct mental model when reading (Chi et al, 1994). Also the relationship between reported strategy use and academic performance after intervention can be positive (McKeachie et al, 1985). However, simply putting together a study skills course will not automatically lead students to develop a deep approach to learning. Hartley (1998) captures the problems that many study skills courses encounter:

"Changing teaching methods and approaches may help some students to become deeper learners, but it is clear that other institutional constraints embedded in the demand for low-cost modular systems may have more over riding considerations as far as the students are concerned." (p96).

Hartley cites research by Gibbs (1992) who describes conditions such as a heavy workload, excessive course material and a lack of choice over subjects and methods as encouraging surface processing while project work, group assignments and independent learning encourage deep learning. Hartley concludes *"It is a sad fact that many courses contain .... features that are likely to encourage surface learning."* So putting into practice some of the above suggestions should not to be undertaken lightly.

One area that lecturers should take greater responsibility is with the feedback they give to students. The findings from reported measures of behaviour (the LASSI, and the MSLQ) suggest that students may come to interpret the success or failure of their study skills solely in terms of the feedback they receive; and this feedback often relates to exam performance. However, feedback can be counter-productive as it can hinder longer-term learning (Schmidt & Bjork, 1992); is less-effective if it is based on measures that the students do not respect, and should be informative and encouraging (McKeachie et al, 1990). Further investigation is needed to explore the facilitative and counter-productive effects of feedback on performance and goal orientation because feedback seems to have a great influence on the students' perceptions of themselves as learners.

There are some methodological issues that need to be considered along with these conclusions. One problem is the low scores obtained with some of measures, such as the low frequency found with some strategies. Alexander et al (1997) summed up the problems of using acclimated learners; "*while the rather low scores for knowledge, strategies, processing and recall supported our contention that we are dealing with learners who were in an acclimation stage .... this very condition added to the problems we encountered in the analysis*" (p 143). In the verbal protocols experiment some measures were low for both groups of learners, and as many statistical procedures require variability in performance, it is difficult to investigate the behaviour of students at this stage of acclimation. There is also the problem of within-groups variability, as some good learners had much higher scores than other good learners, and the same variability was found with the poor learners. This makes the generalization of findings to the student population tenuous. Furthermore, the verbal protocols experiment did detect differences in the way that the students' read the texts and thought aloud their thoughts, but there are probably many other differences that the artificial laboratory setting failed to detect.

Finally, from a standpoint of instruction, the experiments in this thesis suggest that the majority of university students would benefit from instruction in the art of becoming more independent learners. According to Loranger (1994) successful students were more active information processors, purposeful and flexible in their strategy use. But of more concern was the finding that *unsuccessful* students "*perceived themselves as successful learners, and lacked the self-knowledge of their inefficient strategy use*" (p 347). This lack of metacognitive awareness seems to be the best starting point for future research; students need to know *how to become independent learners* before they can take responsibility for their own learning; they need to *become aware of the strategies* that can facilitate their understanding; they need to know *how to use* these strategies; and *how to evaluate* the use of these strategies.

Appendices

Table A1.1 : Reading Strategies Questionnaire

Study Strategies

Verbal Rehearsal

1. Reread some of the material.
2. Underline or highlight the main ideas.
3. Ask myself questions to test my understanding or memory of the material.
4. Restate the material in my own words.

Written Rehearsal

5. Take notes.
6. Make an outline of the material.
7. Summarise the material.

Figural Rehearsal

8. Draw diagrams or pictures related to the material.

Comprehension strategies

Understanding

9. Relate the material to what I already know.
10. Look for logical relations within the material.
11. Mentally identify the most important ideas.

Critical reading

12. Relate the material to my own beliefs and attitudes.
13. Think about how the material could be used.
14. Relate the material to my own experience.
15. Think about my emotional or critical reaction to the material.

Additional items

16. Define terms which are unfamiliar or unusual.
17. Identify ideas which I don't understand.
18. Monitor the success or failure of my comprehension.
19. Relate different parts of the text to get an overall gist of the material.
20. Think of different explanations to challenge the authors' point of view.
21. Make predictions about what may come later in the text.
22. Hope that something difficult will become clearer later.

Table A2.1 : Lassi scales and items

Item	Attitude and Interest (ATT)
5	I don't care if I finish school as long as I find a wife/husband.
14	I feel confused and undecided as to what my educational goads should be.
18	I would rather not be in school.
29	I often feel like I have little control over what happens to me in school.
38	I do not care about getting a general education, I just want to get a good job.
45	I only study the subjects I like.
51	I dislike most of the work in my class.
69	In my opinion, what is taught in my courses in not worth learning.
	Motivation (MOT)
10	I am up-to-date in my class assignments.
13	Even when study materials are dull and uninteresting, I manage to keep working until I finish.
16	I come to class unprepared.
28	I work hard to get a good grade, even when I don't like a course.
33	I talk myself into believing some excuse for not doing a study assignment.
41	I set high standards for myself in school.
49	When work is difficult I either give up or study only the easy parts.
56	I read textbooks assigned for my classes.
	Time Management (TMT)
3	I find it hard to stick to a study schedule.
22	I only study when there is the pressure of a test.
36	When it comes to studying, procrastination is a problem for me.
42	I end up "cramming" for almost every test.
48	I make good use of daytime study hours between classes.
58	When I decide to study, I set aside a specific length of time and stick to it.
66	I put off studying more than I should.
74	I tend to spend so much time with friends that my coursework suffers.
	Anxiety (ANX)
1	I worry that I will flunk out of school.
9	I get discouraged because of low grades.
25	I am very tense when I study.
31	Even when I am well prepared for a test, I feel very anxious.
35	When I begin an examination, I feel pretty confident that I will do well.
54	Worrying about doing poorly interferes with my concentration on tests.
57	I feel very panicky when I take an important test.
63	I get so nervous and confused when taking an examination that I fail to answer questions to the best of my ability.
	Concentration and attention (CON)
6	I find that during lectures I think of other things and don't really listen to what is being said.
11	Problems outside school (being in love, financial difficulties) cause me to neglect my work.
39	I am unable to concentrate well because of restlessness or moodiness.
43	I find it hard to pay attention during lectures.
46	I am distracted from my studies very easily.
55	I don't understand some course material because I don't listen carefully.
61	I concentrate fully when studying.
68	My mind wonders a lot when I study.

Table A2.1 : Lassi scales and items - contined

Item	Information processing and acquiring knowledge (INP)
12	I try to think through a topic and decide what I am supposed to learn from it rather than just read it over when studying.
15	I learn new words or ideas by visualizing a situation in which they occur.
23	I translate what I am studying into my own words.
32	When I am studying a topic I try to make everything fit together logically.
40	I try to find relationships between what I am learning and what I already know..
47	I try to relate what I am studying to my own experiences.
67	I try to see how what I am studying would apply to my everyday situation.
76	I try to interrelate themes in what I am studying.
	Selecting Main Ideas (SMI)
2	I am able to distinguish between more important and less important information in a lecture.
8	I try to identify the main points when I listen to lectures.
60	It is hard for me to decide what is important to underline in a text.
72	Often when studying I seem to get lost in details and "can't see the forest for the trees".
77	I have difficulty identifying the important points in my reading.
	Use of support techniques and materials
7	I use special study helps, such as italics and headings, that are in my textbook.
19	My underlining is helpful when I review text material.
24	I compare class notes with other students to make sure my notes are complete.
44	I key in on the first and/or last sentences of most paragraphs when reading my text.
50	I make drawings or sketches to help me understand what I am studying.
53	I make simple charts, diagrams, or tables to summarize material in my courses.
62	I use chapter headings as a guide to identify important points in my reading.
73	When they are available, I attend group review sessions.
	Self testing, reviewing and preparing for classes (SFT)
4	After a class, I review my notes to help me understand the information.
17	When preparing for an exam, I create questions that I think might be included.
21	I try to identify potential test questions when reviewing my class material.
26	I review my notes before the next class.
30	I stop periodically while reading and mentally go over or review what was said.
37	I check to see if I understand what the instructor is saying during the lecture.
65	I test myself to be sure I know the material I have been studying.
70	I go over homework assignments when reviewing class materials.
	Test strategies and preparing for tests (TST)
20	I do poorly on tests because I find it hard to plan my work within a short period of time.
27	I am unable to summarize what I have just heard in a lecture or read in a textbook.
34	When I study, I have trouble figuring out just what to do to learn the material.
52	I have trouble understanding just what a test question is asking.
59	When I take a test, I realize I have studied the wrong material.
64	I memorize grammatical rules, technical terms, formulas, etc without understanding them.
71	I have difficulty adapting my studying to different types of courses.
75	In taking tests, writing themes, etc. I find I have misunderstood what is wanted and lose points because of it.

Table A2.2 : **Word length and Fog Index of psychology texts.**

	familiar psychology texts			unfamiliar psychology texts		
	topic of text	word length	Fog Index	topic of text	word length	Fog Index
Year 1 cognitive psychology	attention (v1)	535	17.7	learning (v1)	541	17.2
	word processing (v2)	536	15.1	comprehension (V2)	531	15.4
Year 2 cognitive psychology	mental models (v1)	535	17.3	imagery (v1)	537	17.1
	mental models (v2)	540	17.2	semantics (v2)	545	17.8
Year 3 cognitive science	syllogisms (v1)	550	17.5	decomposition (v1)	545	17.6
	discourse (v2)	544	17.4	decomposition (v2)	544	17.0
health	perinatal mortality	541	18.5	motality rates	531	18.4
emotion & stress	emotion-cognition	552	17.5	mood incongruence	531	17.7
visual processes	spatial frequencies	542	18.8	orientation	540	18.6

(v1) text version 1 for cognitive texts (v2) text version 2 for cognitive texts

Table A2.3 : **Word length and Fog Index of non-psychology texts.**

		familiar texts		unfamiliar texts	
	topic of text	word length	Fog Index	word length	Fog index
Year 2 texts	english literature	545	15.0	548	15.0
	english language	537	15.8	530	15.5
	economics	536	15.8	549	15.4
	computer science	539	15.7	535	15.6
	cell biology	539	17.9	549	16.4
Year 3 texts	english literature	545	18.1	543	17.9
	english language	538	17.6	533	17.1
	economics	550	17.3	531	17.6
	computer science	543	18.3	541	17.7
	cell biology	532	17.2	533	17.8

Table A2.4 : Texts used in verbal protocols experiment

Year 1 version 1 familiar cognitive text. From Eysenck, M.W. & Keane, M.T. (1990). *Cognitive Psychology: A students handbook.* Lawrence Erlbaum Associates Ltd, East Sussex. (pp 102 - 103).

How can the various findings on focused attention be explained theoretically? Treisman (1964) favoured a modified version of Broadbent's (1958) theory in which the analysis of unattended information is merely *attenuated* or reduced. Whereas Broadbent had claimed that the bottle-neck occurred early in processing, Treisman suggested that the location of the bottle-neck was more flexible. In essence, she proposed that stimulus analysis proceeds in a systematic fashion through a hierarchy starting with analyses based on physical cues, syllabic pattern, and specific words, and moving on to analyses based on individual words, grammatical structure, and meaning. If there is insufficient capacity to permit full stimulus analysis, then tests toward the top of the hierarchy are omitted. In addition, expected stimuli are treated differently to other stimuli, with the analysing systems being pre-biased towards them.

Treisman's theory clearly accounts for the extensive processing of unattended sources of information that proved embarrassing for Broadbent. However, the same facts can also be explained by a rather different theory put forward by Deutsch and Deutsch (1963). They argued that all incoming stimuli are fully analysed, with one input determining the response on the basis of its importance or relevance in the situation. Their theory is similar to those of Broadbent and of Treisman in postulating the existence of a bottle-neck in information processing, but it is quite different in placing the bottle-neck much nearer the response end of the processing system. A number of subsequent theories follow similar lines (e.g. Shiffrin & Schneider, 1977).

On the face of it, Treisman's theory is more plausible than that of Deutsch and Deutsch. In particular, it seems very uneconomical for all inputs to be analysed completely, and then to have most of the analysed information forgotten almost at once in the way proposed by Deutsch and Deutsch. However, it is much better to adjudicate between theories on the basis of empirical evidence rather than vague notions of plausibility, and Treisman and Geffen (1967) attempted to do just that. Their subjects shadowed one of two concurrent auditory messages, and at the same time monitored both messages in order to detect target words. The detection of a target word was indicated by a simple tapping response.

The crucial findings related to the tapping rates on the two messages. According to Treisman's theory, there should be attenuated analysis of the non shadowed message, and so fewer targets should be detected on that message than on the shadowed one. In contrast the assumption made by Deutsch and Deutsch, namely, that there is complete perceptual analysis of all inputs, leads to the prediction that there should be no difference in detection rates between the two messages. In fact, the shadowed or attended message showed a very large advantage in detection rates over the non shadowed message, with the detection rates being 87% and 8% respectively.

Deutsch and Deutsch (1967) argued since the task used by Treisman and Geffen (1967) required subjects to make two responses to target words appearing in the shadowed message (i.e. shadow and tap) but only one response to targets in the non shadowed message (i.e. tap), there is clearly a sense in which the shadowed targets were more important than the non shadowed ones.

Year 1 version 2 familiar cognitive text. From Eysenck, M.W. & Keane, M.T. (1990). *Cognitive Psychology: A students handbook.* Lawrence Erlbaum Associates Ltd, East Sussex, (pp 301 - 302).

An apparently simple task is to repeat a spoken word immediately after you have heard it. However, there are many brain damaged patients who experience difficulties with this task, despite the fact that audiometric testing reveals that they are not deaf. Detailed analysis of these patients has suggested that there are actually a number of somewhat different processes which can be used to permit repetition of a spoken word. Information from such patients was used by Ellis and Young (1988) to propose a model of the processing of spoken words.

In essence, their model consists of five components. The *auditory analysis system* is used to extract phonemes or other sounds from the speech wave. The *auditory input lexicon* contains information about spoken words known to the listener, but does not contain information about their meaning. The purpose of the auditory input lexicon is to recognise familiar words via the activation of the appropriate word units. The

Table A2.4 : Texts used in verbal protocols experiment - continued

meanings of words are stored within the *semantic system*, about which relatively little is known. The *speech output lexicon* serves to provide the spoken forms of words. Speech sounds themselves are available at the *phoneme level*. These components can be used in various combinations, so that there are three different routes between hearing a spoken word and saying it. Routes 1 and 2 are discussed below.

Route 1 makes use of the auditory input lexicon, the semantic system, and the speech output lexicon. It represents the normal way in which familiar words are identified and comprehended by those with no brain damage. If a brain damaged patient could use only this route, then one would expect that familiar words could be said correctly. However, there would be severe problems with saying unfamiliar words and nonwords, because they do not have entries in the auditory input lexicon.

Route 2 makes use of the auditory input lexicon and the speech output lexicon. If a patient could use Route 2, but Route 1 was severely impaired, one would expect that he or she would be able to repeat familiar words but would often find it difficult to understand what the words meant. Patients suffering from a condition known as "word-meaning deafness" seem to fit this description. Ellis (1984) reprinted the case of a young woman reported by Bramwell (1897). She could understand written sentences reasonably well, and she could say sentences that were spoken to her, and even write them down to dictation. However, she found it extremely difficult to understand things that were said to her. While the precise nature of the impairment producing this condition is not known for certain, Ellis and Young (1988) have suggested that it may represent "a complete or partial disconnection of the auditory input lexicon from the semantic system". This seems reasonable, since the ability of patients with word-meaning deafness to understand written words implies that the semantic system is relatively intact, and their ability to write to dictation implies that the auditory input lexicon is not impaired. If there were a problem of communication between the auditory input lexicon and the semantic system, the main consequence would be a difficulty in understanding spoken words, and that is precisely what is involved in word meaning deafness.

Year 1 version 1 unfamiliar cognitive text. From Stevenson, R.J. & Palmer, J. (1994). *Learning: Principles, Processes and Practices*. Cassell Education Ltd, London. (pp 177-178).

Explicit learning is concerned with two main activities. One is understanding new material, which depends crucially on activating pre-existing implicit knowledge when learning occurs. The second is concerned with consolidating newly understood material so that it can be used automatically and make further explicit learning possible. Consolidation of conceptual knowledge is achieved through memorization: the material is repeatedly revised until it can be retrieved from long-term memory without conscious reflection. Consolidation of procedural knowledge - knowledge of actions and strategies - is achieved through practice of problem-solving skills until they too can be retrieved automatically from long-term memory. Understanding and consolidation need to occur hand in hand, but there is a constant danger that what gets consolidated is material that has not been properly understood. This will happen whenever prior knowledge has not been activated during learning. If understanding is pre-empted by problem solving or memorization in this way, new learning will be considerably impaired, a situation that is likely to get progressively worse as schooling progresses. To avoid such a lamentable state of affairs, it is important to see how learning through understanding makes use of prior knowledge and how understanding is different from problem solving and memorization. Let us therefore, restate these three basic categories of explicit learning.

Firstly, *understanding* involves integrating new material with prior knowledge, but it also goes beyond simple integration to a two-way process of evaluation, in which prior knowledge is used to assess how well the new material has been understood, and the new material is used to evaluate and modify pre-existing knowledge. Prior knowledge is thus a key ingredient: first, it is needed to assess the comprehension of new material: second, it is assessed, updated and revised in the light of that material, a process ensuring that misconceived prior beliefs are corrected.

Secondly, *problem solving* involves discovering, or being told, the solution to a problem and how to arrive at that solution. Once the solution and how to reach it is known, the problem can be repeated many times until it can be retrieved from memory automatically and the individual steps in the problem-solving process become part of implicit knowledge. Without the involvement of prior knowledge to give significance to the task, problem solving becomes an end in itself. This can be seen in mathematics, where what is learned is a set of arbitrary and abstract procedures without any understanding of why or how they work.

Table A2.4 : Texts used in verbal protocols experiment - continued

Thirdly, *memorization* involves consolidation, through revision of newly understood material until it too can be automatically retrieved from memory without conscious effort. Unfortunately, as was the case with problem solving, memorization too is often seen as a learning goal in itself and material is memorized with few, if any, attempts to understand it. Material learned in this way may be superficially integrated with prior knowledge, but since the two-way process of evaluation is not applied, understanding is also superficial. The use of memorization without full understanding is implicitly encouraged in schools wherever there is an emphasis on how much is learned rather than how well it has been understood. Both problem solving and memorization therefore, need to be seen as ways of consolidating material that has already been understood and making it automatic through practice.

Year 1 version 2 unfamiliar cognitive text. From Stevenson, R.J. (1993). *Language Thought and Representation.* John Wiley & Sons, Chichester. (pp 104 - 105).

People have proposed that two distinct types of representation are constructed during reading and these have often been portrayed as competing theories. One view suggests that texts are represented as propositions that, together with some minimal inferences, form what has been called the text-based representation (e.g. Kintsch and van Dijk, 1978; McKoon and Ratcliff, 1980). An alternative view proposes that comprehension relies on representational elements that reflect aspects of the real-world situations that are described by the text (e.g. Schank and Abelson, 1977; Sanford and Garrod, 1981). More recently, however, theorists have suggested a combined approach to representational issues, such that both kinds of representation contribute to comprehension (e.g. Glenberg, Meyer and Lindem, 1987; van Dijk and Kintsch, 1983; Johnson-Laird, 1983).

Johnson-Laird (1983) argues that text comprehension involves both a linguistic (propositional) representation and a mental model. A propositional representation is very similar to the wording of the text, except that the units are concepts rather than words and that the syntactic relations are specified. A mental model represents the state of affairs described by the text. It is structurally similar to part of the world rather than to any linguistic structure. Information that is not explicitly mentioned in a text can be included in a mental model, by means of inferences from general knowledge acting in conjunction with the propositional representation.

Van Dijk and Kintsch (1983) have made similar suggestions. They propose three levels of representation: a surface, or syntactic level, a propositional text base, and a situational model. At the surface level, the text is represented by the exact words and phrases used. At the text-based level, the semantic content of the text is represented, not the original wording. This level is comparable to Johnson-Laird's propositional representation. At the situational level, the situation described by the text is represented, detached from the text structure proper and embedded in pre-established fields of knowledge. This level is comparable to Johnson-Laird's mental model.

These representations form the episodic memory for the text. They can be thought of as being held in a distinct episodic store that therefore contains all the information stated in the text together with additional (inferred) schema-based information. Alternatively, only the new information may be held in a distinct episodic memory for the text, with the old and inferred information being simply tagged in long-term memory as part of the text (e.g. McKoon, Ratcliff and Seifert, 1989). Regardless of the precise relationship between episodic and long-term semantic memory, it is evident that these different representations are constructed during comprehension.

These representations have different decay rates and different situations favour their construction. If a text is compatible with more than one mental model, if subjects are deliberately trying to memorize the text, or if the subjects have little or no specific knowledge of the concepts being described, then people will tend to rely on a propositional representation and not construct a mental model. However, if the text is compatible with a single mental model, if subjects are trying to comprehend rather than memorize the text, or if the subjects have specific knowledge of the relevant concepts so that inferences can be made, then people will construct a mental model.

Table A2.4 : Texts used in verbal protocols experiment - continued

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Year 2 version 1 familiar cognitive text. From Johnson-Laird, P.N. (1983) *Mental Models*. Harvard University Press, Cambridge, Mass. (pp243-244).

Bransford, Barclay, and Franks (1972) advanced a hypothesis that distinguished between an 'interpretive' and a 'constructive' approach to semantics. An interpretive theory assumes that the semantic interpretation assigned to a sentence provides a full analysis of its meaning. A constructive theory, which these authors advocated, postulates that individuals construct interpretations that go beyond the linguistically given information. Barclay (1973) illustrated the contrast by presenting two groups of subjects with sentences that described the serial order of five animals standing in a row. One group was told to work out the order, and another group, which was not told that the sentences described a serial order, was instructed merely to memorize the sentences. In a recognition test, the first group did not distinguish reliably between the original sentences and other sentences that were true of the array, whereas the second group, the memorizers, were only able to discriminate between sentences which introduced items not originally interrelated and the remaining sentences in the memory test.

Our evidence on memory for spatial descriptions suggests a theory of comprehension in which there are two stages. In the first, a superficial understanding of an utterance gives rise to a propositional representation, which is close to the surface form of the sentence. This symbolic representation is constructed in a mental language that has a vocabulary of comparable richness to that of natural language - a hypothesis independently urged both by Kintsch (1974) and Fodor, Fodor, and Garrett (1975). Propositional representations encode sufficient information to enable verbatim information to be recalled, at least for a brief interval of time. They provide an economical way of representing discourse, especially indeterminate descriptions. They are likely to resemble surface form rather than direct phonetic (or graphemic) transcriptions of an utterance, since it is almost impossible for native speakers to suppress the process of identifying words and recovering some syntactic relations. The second stage of comprehension which is optional, makes use of propositional representations as a partial basis for the construction of a mental model, whose structure is analogous to the state of affairs described by the discourse. Hence the recovery of a propositional representation is a necessary precursor to the construction of a mental model. The constructive process is also guided by contextual cues and implicit inferences based on general knowledge.

Suppose, to take an example from Johnson-Laird (1975b), you are asked whether you understand the following sentence:

The elderly gentlemen often walked the streets of the town.

If you are a reasonably proficient speaker of English, then you will have no difficulty grasping its meaning. You know the meanings of its words and you know how to combine them according to their syntactic relations. But do you grasp the significance of the statement, that is, the proposition that it expresses? Of course not. It is merely a sentence that you have come across in a book on language. If you had read it in a town guide, however, and inferred that the *elderly gentleman* referred to Einstein and *the town* referred to Princeton, then you know who and what it was about. You would be well on the way to grasping its *significance*, since you would have recovered the particular proposition that it conveyed in context.

Year 2 version 2 familiar cognitive text. From From Johnson-Laird, P.N. (1983) *Mental Models*. Harvard University Press, Cambridge, Mass. (pp244-245).

Our evidence for spatial descriptions suggests a theory of comprehension in which there are two stages. In the first stage, a superficial understanding of an utterance gives rise to a propositional representation, which is close to the surface form of the sentence. This symbolic representation is constructed in a mental language that has a vocabulary of comparable richness to that of natural language - a hypothesis independently urged by both Kintsch (1974) and Fodor, Fodor, and Garrett (1975). The second stage of comprehension, which is optional, makes use of propositional representations as a partial basis for the construction of a mental model, whose structure is analogous to the state of affairs described by the discourse. Hence the recovery of a propositional representation is a necessary precursor to the construction of a mental model. The constructive process is also guided by contextual cues and implicit inferences based on general knowledge.

The theory of mental models, elucidates this second stage of comprehension. The essential context of an utterance can be represented in a mental model, and the significance of the utterance is established by relating its propositional representation to this model and to general knowledge. When the referents have been identified, the new information conveyed by the utterance can then be added to the model to bring it up to date. This process, however, may well occur clause by clause, or constituent by constituent, rather than at the level of complete sentences.

Building a mental model from a propositional representation clearly demands an extra amount of processing over that required to set up a propositional representation alone. This difference leads to the prediction that a model should be better remembered than a proposition. Indeed, a model goes beyond the literal meaning of the discourse, because it embodies inferences, instantiations, and references; the meaning of the sentence is not recoverable from the model. The experimental findings have confirmed these hypotheses. The constructive process is likely to be slowed down by any expressions that are difficult to interpret, such as negatives and semantically 'marked' words, but once a model has been constructed, these variables should have a negligible effect - a conjecture that has also been confirmed experimentally (see Glushko and Cooper, 1978).

One other phenomenon is worth noting, as it bears out the distinction between propositional representations and models. The existence and efficacy of euphemisms depends on the possibility of superficial interpretations of discourse. If a word always evoked a complete representation of its denotation, then the almost universal human propensity to call a spade, not a spade, but an 'implement for excavating earth; would serve no purpose. The exotic terminology of death and burial - so notably satirized by Evelyn Waugh in *The Loved One* - would never have been invented. Euphemisms are designed to be represented propositionally and to deter full interpretation. Obscene words in their literal meanings, however, are designed to lead straight to a model of the world. Apart from their emotive use as swear words, they are so redolent of the things they name that even adults are prey to confusing the name for the thing. Unlike inventing euphemisms, it is extremely difficult to make up a new obscenity, because such an invention almost demands the creation of a new obscene act.

Year 2 version 1 unfamiliar cognitive text. From Johnson-Laird, P.N. (1983) *Mental Models*. Harvard University Press, Cambridge, Mass. (pp 152-153).

Although some commentators see the question of the machine's code and architecture as fundamental, from the standpoint of functionalism it trivializes the controversy between the imagists and the propositionalists. Pylyshyn (1981), for instance, argues that images are epiphenomenal and not part of the functional architecture of the machine because they are 'cognitively penetrable'. That is, the way in which they govern behaviour can be influenced in a rationally explainable way by beliefs, goals, and tacit knowledge. Hence, he claims, images depend on a cognitive rule-governed process that acts on semantically interpreted representations rather than on the intrinsic properties of an underlying analogue medium. All these assumptions can be granted to Pylyshyn, though whether anything from ulcers to short-term memory fails to be 'cognitively penetrable' might be difficult to determine. The real trouble is that Pylyshyn has pitched the battle in the wrong place. To see why, one only has to consider how a thoroughgoing materialist (cf. Churchland, 1981) might react to Pylyshyn's recourse to beliefs, goals, and tacit knowledge. Such notions, the materialist might say, are epiphenomenal and not part of the functional architecture of the machine because they are 'imagistically penetrable'. That is, the way in which they govern behaviour can be influenced in a rationally explainable way by images. The moral is plain: images and beliefs are both high-level constructs, and it is a mistake to argue that they are epiphenomenal just because they can 'penetrate' each other.

The level at which a particular mental entity is described is indeed a source of much confusion in theoretical discussions. A theorist might propose, for example, that a mental image consists of a two-dimensional array built up from some internal description. Such a hypothesis is informal, but at a high level - the level at which psychological discourse is normally conducted. A specification of the theory at a lower level would describe

Table A2.4 : Texts used in verbal protocols experiment - continued

the underlying representation of the arrays and the otherwise invisible machinery that makes them possible. From the standpoint of functionalism however the neurophysiological embodiment of the array is irrelevant even if it is expressed within a uniform propositional code. There is an analogy with computer programming here: an array is a structure in which elements can be accessed and updated by giving appropriate ordered sequences of integers corresponding to co-ordinate values. Programmers need to know no more: they can devise algorithms for manipulating arrays simply by thinking of them as n-dimensional spaces where each location is specified by an n-tuple of integers. There is, of course, no corresponding physical array of locations in the computer. That would be wholly unnecessary. All that matters is that the physical embodiment should *function* as an array, that is, there is a set of locations that can be used as an array. Its elements can be accessed as an array and its contents displayed or manipulated as an array. The machine code that controls a particular computer as it processes an array is a translation of the program into a low-level description in which these functional principles are no longer evident. Likewise, the redescription of a theory of imagery at the level of a Turing machine - the lowest theoretical level - almost entirely obscures its operational principles.

Year 2 version 2 unfamiliar cognitive text. From Johnson-Laird, P.N. (1983) *Mental Models*. Harvard University Press, Cambridge, Mass. (pp 262 - 263).

The theory of procedural semantics has implications for the status of semantic primitives. The meanings of basic spatial terms such as *right* and *left* cannot be lexically analysed in decompositional dictionary entries of the standard sort. This is because it is impossible to define these words in more primitive terms. Yet the fact that they are indefinable does not mean that they are primitives. On the contrary, the spatial program makes use of procedural primitives, such as freezing in the values of incremental parameters, in coping with the semantics of these words. The meanings of the words in the object language (a highly restricted subset of English) are formulated in procedural terms that have no simple - let alone one-to-one - relation to the object language. As far as the object language is concerned, the primitives are ineffable just as the true semantic primitives underlying our use of language are ineffable and inevitably a matter for scientific investigation. The program illustrates the need to employ such primitives in order to specify the truth conditions of expressions. It specifies them, not in relation to the real world, but in relation to *models* of the world. Human beings know how to relate expressions to models of the world. Unlike the program, however, they have ways of constructing such models that are not dependent on a linguistic input.

On the basis of his mimicry theorem, Anderson (1978) has argued that any psychological behaviour based on semantic primitives can be equally well computed with the aid of meaning postulates. Although the theorem is sound, the claim is false. Meaning postulates in a psychological theory are intended to capture entailments (Fodor, 1975, p. 149). They represent the semantic properties of a word and its semantic relations to other words, but not its contribution to truth conditions. The truth conditions of many words are indeed impossible to formulate in the object language, just as, for example, there is no way to define the meaning of *on the right and on the left* in the language used as input to the computer program. There is thus no way to capture such truth conditions by using meaning postulates, which interrelate terms in the object language. A semantics based on procedural primitives, however, can represent truth conditions. Hence, a theory that employs semantic primitives transcends the mimicking propensities of meaning postulates.

The theory of mental models suggests that what children have to acquire are the truth conditions of expressions - more accurately, the contribution that expressions make to the truth conditions of sentences. Once they have a working knowledge of this aspect of a word they will have implicitly mastered its logical properties, given that the general skills of constructing and manipulating mental models are available to them. The intensions of words, however, are not specified in isolation. As our earlier analysis of vagueness revealed, words are organised taxonomically, and hence the route to acquiring their intensions is likely to be taxonomic too. The procedural primitives are therefore likely to be organised into a taxonomic device, such as a decision table (Miller and Johnson-Laird, 1976), that provides the structure for the relevant lexical domain. Moreover, children who reflect upon the invariant properties of a word may in time come to represent them in the form of meaning postulates.

Table A2.4 : Texts used in verbal protocols experiment - continued

Year 2 familiar english literature text. From Houghton, W.E. (1957). *The Victorian Frame of Mind*. Oxford University Press, London. (pp 124-126).

Democratic theories of popular sovereignty and the equality of man extended the right of private judgment to all men, and that meant, in effect, the exalting of natural shrewdness at the expense of the trained intellect. No need for special knowledge or theoretical analysis: the answers were available to the common sense of the common man. This notion was encouraged by the contemporary state of learning. In an age of transition when established beliefs are questioned and new ones debated, "the divisions among the instructed," as Mill observed, "nullify their authority, and the uninstructed lose their faith in them;" with the result that "persons who have never studied any branch of knowledge comprehensively . . . attempt to judge for themselves upon particular parts of it." That intellectual levelling, so to speak, merged with democratic dogma to create the state of affairs which Mill described in *The Spirit of the Age* (1831): Every dabbler . . . thinks his opinion as good as another's.... It is rather the person who *has* studied the subject systematically that is regarded as disqualified, He is a *theorist:* and the word which expresses the highest and noblest effort of human intelligence is turned into a bye-word of derision. Men form their opinions according to natural shrewdness, without any of the advantages of study. In this way political theory supported the influence of business - how closely can be seen in a passage of Bagehot's which parallels this one of Mill's, but with a different point of reference. "A man of business hates elaborate trifling: 'If you do not believe *your own* senses,' he will say, 'there is no use in *my* talking to you.' As to the multiplicity of arguments and the complexity of questions, he feels them little, he has a plain, simple - as he would say, 'practical' - way of looking at the matter, and you will never make him comprehend any other."

Another major factor in the intellectual - or we might say the anti-intellectual - environment was Victorian Puritanism. Although the eighteenth-century evangelical men like Isaac Milner, Thomas Scott, and John Newton, were concerned with theology, the pietistic core of the Wesleyan movement soon came to the front. In the Clapham Sect emphasis had shifted to works of charity and philanthropy - fighting the slave trade, establishing foreign missions, distributing Bibles. By 1839 Newman could argue, without much exaggeration, that "Evangelical Religion or Puritanism .... had no intellectual basis; no internal idea, no principle of unity, no theology." A little later Mark Pattison traced "the professed contempt of all learned inquiry, which was a principle with the Evangelical school" to its protest against the intellectual, if too dry and rational, character of eighteenth-century apologetics: "Evangelism, in its origin, was a re-action against the High-Church 'evidences'; the insurrection of the heart and conscience of man against an arid orthodoxy. It insisted on a 'vital Christianity,' as against the Christianity of books. Its instinct was from the first against intelligence. No text found more favour with it than 'Not many wise, not many learned.' If we add to this its strongly authoritarian principles - the assumed infallibility of the Bible on all questions and the repression of all who stir up theological discussions; - we have little difficulty accounting for middle-class philistinism from its religious, no less than its commercial, life.

Year 2 unfamiliar english literature text. From Wordsworth, J. (1982). *William Wordsworth: The Borders of Vision*. Clarenden Press, Oxford. (pp 362-363)

Spring 1804 is the period not just of Coleridge's departure, but of Wordsworth's greatest philosophical poetry. February had seen the Climbing of Snowdon with its celebration of the creative human mind, 'made in God's image'; and sandwiched between the two letters of March demanding material come the great central passages of *Prelude*, Book VI. Imagination, which Coleridge in 1815 regards as the basis of *The Recluse*, becomes the dominant force in *The Prelude* at a moment when Wordsworth seems to be especially conscious of lacking help for his major work.

No doubt what Wordsworth really wanted from Coleridge's notes was magic, sudden Illumination, spontaneous awareness as to how one should set about delivering *upon authority* a system of philosophy. It was not that he had difficulty in assimilating Coleridge's thinking on imagination into his poetry; like the related earlier dogma of the One Life, it gave its support to truths that had been intuitively perceived. To present such truths within a system was another matter, Coleridge never succeeded in doing it for himself, and it is very doubtful whether his notes would have been any use to Wordsworth even if he had been able to write them. In content they would have resembled the philosophical sections of *Biographia*; but these are successful (or acceptable) only because, like the comparable sequences of *The* Prelude, they grow out of the surrounding personal and literary context. A more systematic removal of 'the sandy sophisms of Locke' could never have been poetic material, Wordsworth's faith in Coleridge is touching, but hopeless. Though he could not have known it, in *The Prelude* he was writing the great philosophical poem that *The Recluse* was intended to be, and writing it - as Coleridge was to write his 'Literary Life and Opinions', not the *Logosophia* - in the form and idiom that corresponded especially to the patterns of his thought. When *The Prelude* was completed in the full-length version of May 1805 there was never a hope of further progress, the flanking *Excursion* could still be written, but the scheme of *The Recluse* would have finally to do without its centrepiece.

The most poignant moments in the history of The Recluse are those when, as on Boxing Day 1805, Dorothy refers to her brother as 'very anxious to get forward', and 'reading for the nourishment of his mind, preparatory to beginning'. Wordsworth was once more free to get on with his major task; and the pressure on him was now greater than ever, because writing had come to seem the fulfilment of a bond with the dead. John, as captain of the *Earl of Abergavenny,* had regarded himself as working so that his brother, in seclusion, could 'do something for the world '. 'This is the end of his part of the agreement, of his efforts for my welfare', Wordsworth had written on 23 February 1805, twelve days after the news of John's death, 'God grant me life and strength to fulfil mine . . . there is a bond between us yet, the same as if he were living, nay far more sacred'. Sense of this obligation had no doubt helped him to finish *The Prelude* in May, but failed to carry him on into the main part of *The Recluse* as he must have hoped would be the case.

Year 2 familiar biology text. From Janeway, C.A. & Travers, P. (1994) *Immunology, The Immune System in Health and Disease*. Garland Publishing Inc, London. (pp 1:9-1.11)

Lymphocytes can produce receptors with an almost infinite range of specificities. This requires that they are able to form very large numbers of distinct receptor molecules. The long-standing question of how such diversity could be encoded within a finite number of genes was finally answered in 1976, when Susumu Tonegawa discovered the nature of the genes that encode immunoglobulins, the antigen receptors of B cells.

The ability of different antibodies to bind specifically to different antigens results from their highly variable structure. Each of the two polypeptide chains that assemble to make the antigen-binding site has a variable and a constant region. The variable region determines its antigen specificity, and the constant region defines its function. In the mid-1970s it was found that the genes for antibody variable regions are inherited as sets of **gene segments,** each of which encodes a part of the variable region of one or other of the polypeptide chains. As B lymphocytes differentiate in the bone marrow, these gene segments are joined to form a stretch of DNA that codes for the entire variable region. Because different gene segments are joined in different cells, each cell forms a unique gene for the variable region of each chain of the antibody molecule. This mechanism has three important consequences. First, it enables a limited number of gene segments to generate a very diverse set of proteins. Second, as each cell assembles a different set of gene segments in forming its antigen receptor, each cell expresses a unique receptor specificity. Third, as gene rearrangement involves an irreversible change in a cell's DNA, all the progeny of that cell will inherit genes encoding the same receptor specificity.

This general scheme was later confirmed for the genes encoding the antigen receptor on T lymphocytes. The main distinction between B and T lymphocyte receptors is that the cell-surface immunoglobulin molecule that serves as the B-cell receptor has two identical antigen recognition sites. In contrast, the **T-cell** receptor is smaller and has a single recognition site. We shall see later that these receptors also recognize antigen in very different ways.

The potential diversity of lymphocyte receptors generated in this way is enormous. Just a few hundred different gene segments can combine in different ways to generate tens of thousands of different receptor chains. The diversity of lymphocyte receptors is increased further by the fact that each receptor is made by pairing two different variable chains, each encoded in distinct sets of gene segments. A thousand different chains of each type could generate 10^6 distinct antigen receptors through this **combinatorial diversity.** Thus a small amount of genetic material can encode a truly staggering diversity of receptors. There are at least 10^8 different lymphocytes in an individual. Once gene rearrangement is complete, the genes are expressed and the developing lymphocyte begins to display a specific antigen receptor on its surface. It is now ready to interact with antigen in its environment.

Table A2.4 : Texts used in verbal protocols experiment - continued

The random gene rearrangement process that generates the diverse repertoire of lymphocyte receptors inevitably generates receptors able to recognize self antigens. However, we normally do not make immune responses against our own tissues, even though we produce lymphocytes whose receptors are specific for our own tissue antigens. This is called **self tolerance.**

Year 2 unfamiliar biology text. From Gilbert, S.F. (1988). *Developmental Biology.* Sinauer Associates Inc, Mass. (pp 199-210).

One of the major tasks of gastrulation is to position the endoderm deep within the embryo and to sandwich the mesodermal cells between the ectodermal and endodermal layers. The formation of mesodermal and endodermal organs is not subsequent to neural tube formation, but occurs synchronously. Those mesodermal cells of the chick that are not involved in notochord formation have migrated laterally to form thick bands running longitudinally along each side of the notochord and neural tube. These bands of PARAXIAL MESODERM are referred to as the SEGMENTAL PLATE (in birds) and the UNSEGMENTED MESODERM (in mammals). As the primitive streak regresses and the neural folds begin to gather at the center of the embryo, the paraxial mesoderm separates into triangular blocks of cells called SOMITES. The first somites appear in the anterior portion of the embryo, and new somites are formed posteriorly at regular intervals, budding from the paraxial mesoderm. Because embryos develop at different rates when incubated at slightly different temperatures, the number of somites present is usually the best indicator as to how far development has proceeded. The total number of somites formed is characteristic of a species.

The mechanism for somite formation is not well established. but recent studies in chicks have shown that the cells of the segmental plate may be organized into whorls of cells called SOMITOMERES (Meier, 1979). The chick segmental plate is consistently seen to have 10 to 1l pairs of somitomeres that eventually become somites (Packard and Meier, 1983). Conversion from somitomere to somite is seen as the cells of the most anterior somitomere become compacted. Lash and Yamada (1986) have speculated that fibronectin mediates the clumping of the somitomere cells. Their hypothesis is based on two types of data. First, Ostrovsky and co-workers (1984) demonstrated that the amount of fibronectin increases in the anterior region of the presumptive somite at the same time that the cells in the anterior border of this tissue start to compact. The second type of evidence comes from *in vitro* studies. Lash and co-workers (1984; Cheney and Lash, 1984) found that dissociated cells from the anterior portions of the chick segmental plate (which have already formed somites) readily reassociate into somite-sized clumps. Dissociated cells from the posterior portion of the segmental plate (which has not yet formed somites) do not reassociate well. This suggests that the mesodermal cells become more adhesive as they gain the ability to form somites. The posterior cells could be induced to form somite-like masses by adding fibronectin to the culture medium in which they were reaggregating.

As the somite becomes a coherent entity, its cells become epithelial, and the outer cells of the somites become attached to each other by tight junctions. Like the notochord and the neural tube, the somite becomes covered with a BASAL LAMINA consisting of collagen, fibronectin, laminin, and glycosaminoglycans (GAG). In fact, GAG from the neural tube and notochord appear to induce the somites to secrete their own GAG. If the GAGs are enzymatically removed from the surface of the notochord, GAG synthesis in the somites will stop until the notochord once more has elaborated GAG on its own surface. Whether through the action of GAG or some other factor, the *ventral* cells of the somite (the cells located farthest from the back) undergo mitosis.

Familiar computer science text. From Rich, E. & Knight, K. (1991). *Artificial Intelligence.* McGraw-Hill Inc, Singapore. (p 307-308).

Games hold an inexplicable fascination for many people, and the notion that computers might play games has existed at least as long as computers. There were two reasons that games appeared to be a good domain in which to explore machine intelligence: Firstly, they provide a structured task in which it is very easy to measure success or failure, and secondly they did not obviously require large amounts of knowledge. They were thought to be solvable by straightforward search from the starting state to a winning position. The

Table A2.4 : Texts used in verbal protocols experiment - continued

first of these reasons remains valid and accounts for continued interest in the area of game playing by machine. Unfortunately, the second is not true for any but the simplest games. For example, consider chess where the average branching factor is around 35, and in an average game each player might make 50 moves, so in order to examine the complete game tree, we would have to examine 35^{100} positions. Thus it is clear that a program that simply does a straightforward search of the game tree will not be able to select even its first move during the lifetime of its opponent. Some kind of heuristic search procedure is necessary.

One way of looking at all the search procedures we have discussed is that they are essentially generate-and-test procedures in which the testing is done after varying amounts of work by the generator. At one extreme, the generator generates entire proposed solutions, which the tester then evaluates. At the other extreme, the generator generates individual moves in the search space, each of which is then evaluated by the tester and the most promising one is chosen. Looked at this way, it is clear that to improve the effectiveness of a search-based problem-solving program two things can be done. Firstly improve the generate procedure so that only good moves (or paths) are generated; and secondly improve the test procedure so that the best moves (or paths) will be recognized and explored first.

In game-playing programs, it is particularly important that both these things be done. Consider again the problem of playing chess, on average, there are about 35 legal moves available at each turn. If we use a simple legal-move generator, then the test procedure (which probably uses some combination of search and a heuristic evaluation function) will have to look at each of them. Because the test procedure must look at so many possibilities, it must be fast, so it probably cannot do a very accurate job. Suppose, on the other hand, that instead of a legal-move generator, we use a *plausible-move generator* in which only some small number of promising moves are generated. As the number of legal moves available increases, it becomes increasingly important to apply heuristics to select only those that have some kind of promise. (So, for example, it is extremely important in programs that play the game of go [Benson *et al.*, 1979]. With a more selective move generator, the test procedure can afford to spend more time evaluating each of the moves it is given so it can produce a more reliable result. Thus by incorporating heuristic knowledge into both the generator and the tester, the performance of the overall system can be improved.

Year 2 unfamiliar computer science text. From Allen, J. (1995). *Natural Language Understanding.* Benjamin - Cummings, California. (pp 228-9).

Can we define a notion of a sentence meaning that is independent of context? In other words, is there a level at which the sentence *Do you know what gate you are going to?* has a single meaning, but may be used for different purposes? This is a complex issue, but there are many advantages to trying to make such an approach work. The primary argument is modularity. If such a division can be made, then we can study sentence meaning in detail without the complications of sentence usage. In particular, if sentences have no context-independent meaning, then we may not be able to separate the study of language from the study of general human reasoning and context. There are many examples of constraints based on the meaning of words that appear to be independent of context. So from now on, we will use the term *meaning* in this context-independent sense, and we will use the term *usage* for the context-dependent aspects. The representation of context-independent meaning is called the logical form. The process of mapping a sentence to it's logical form is called semantic interpretation, and the process of mapping the logical form to the final knowledge representation (KR) language is called contextual interpretation.

For the moment let us assume the knowledge representation language is the first-order predicate calculus (FOPC). Given that assumption, what is the status of the logical form? In some approaches the logical form is defined as the literal meaning of the utterance, and the logical form language is the same as the final knowledge representation language. If this is to be a viable approach in the long run, however, it would mean that the knowledge representation must be considerably more complex than representations in present use in AI systems. For instance, the logical form language must allow indexical terms, that is, terms that are defined by context. The pronouns *I* and *you* are indexical because their interpretation depends on the context of who is speaking and listening. In fact most definite descriptions (such as *the red ball*) are indexical, as the object referred to can only be identified with respect to a context. Many other aspects of language, including the interpretation of tense and determining the scope of quantifiers, depend on context as well and thus cannot be uniquely determined at the logical form level. Of course, all of this could be treated as ambiguity at the logical form level, but this would be impractical, as every sentence would have large numbers of possible logical forms (as in the sentence *The red ball dropped*, which would have a different logical form for every possible object that could be described as a ball that is red).

But if the logical form language is not part of the knowledge representation language, what is its formal status? A promising approach has been developed in linguistics over the last decade that suggests an answer that uses the notion of a situation, which is a particular set of circumstances in the world. This corresponds reasonably well to the intuitive notion of the meaning of *situation* in English. More formally, you might think of a situation as a set of objects and relations between those objects.

Year 2 Familiar english Language text. From Haegeman, L. (1994). *Introduction to Government & Binding Theory*. Blackwell Publishers, Oxford. (p43-44).

Logicians have long been concerned with formulating representations for the semantic structure of sentences, or more correctly propositions. In the notation of formal logic, (18a) is assigned the representation (18b):

18a Maigret imitates Poirot.
18b A (mp)
where A = 'imitate', m = 'Maigret' and p = 'Poirot'.

(18a) contains the NPs Maigret and Poirot, two referring expressions, that is expressions which serve to pick out an entity, a person, a thing, from those things we are talking about, the universe of discourse. It also contains a predicate *imitate*. The predicate does not refer to a person or thing but rather defines some relation between the referring expressions. In the logical notation in (18b) we see that the predicate 'imitate' takes two arguments, represented by m (for Maigret) and p (for Poirot). Predicates that require two arguments are two-place predicates. The transitive verbs of traditional syntax correspond approximately to the two-place predicates of logic. The arguments of a predicate are realized by noun phrases in our example: in (18a) the subject NP is one argument and the object NP is the second argument of the verb *imitate*. Intransitive verbs correspond to one-place predicates: they take only one argument.

19a Maigret stumbled.
19b S (m)
where S = 'stumble' and m = 'Maigret'.

Using the basic idea of formal logic outlined above, we can say that every predicate has its argument structure, i.e. it is specified for the number of arguments it requires. The arguments are the participants minimally involved in the activity or state expressed by the predicate. We could use a metaphor to summarize this: predicates are like the script of a play. In a script a number of roles are defined and will have to be assigned to actors. The arguments of a predicate are like the roles defined by the script of a play. For an adequate performance of the play, each role must be assigned to an actor. It will not do either to miss out on a part in the play or to have actors on the stage who have no part to play. Adjuncts might be compared to the parts in the script which are not central to the play. The argument structure of a verb determines which elements of the sentence are obligatory. If a verb expresses an activity involving two arguments there will have to be at least two constituents in the sentence to enable these arguments to be expressed. This conceptually defined argument structure can partly replace the classification of verbs in terms of either transitivity labels or subcategorization frames. If a speaker knows the meaning of the verb *meet*, in other words if he knows what activity is expressed, he will also know how many participants are involved and hence how many arguments the verb takes. 'Meet' involves two participants, and hence will be expected to take two arguments, if one argument is realized as the subject of the sentence, it follows that *meet* will select one VP-internal complement. This does not mean that we can conclude that the verb *meet* necessarily subcategorizes for a NP, after all, the arguments might have been realized by categories other than NP. The argument structure of the verb predicts the number of constituents needed, but not necessarily their type.

Table A2.4 : Texts used in verbal protocols experiment - continued

Year 2 unfamiliar english language text. From Huang, C.T.J (1989). Pro Drop in Chinese: A Generalized Control Theory. In Jaeggli, O. & Safir, K.J. (Eds). *The Null Subject Parameter*. Kluwer Academic Publishers, London: (pp185-186)

In recent years considerable attention has been devoted to the study of control and pro-drop the former referring to the occurrence of a null pronominal in the subject position of a non-finite clause. and the latter referring to that of a null pronominal in other positions. The most important questions that surround these null elements include the following: (a) What is their distribution across language? (b) What are their referential properties? (c) How may their distribution and reference be properly accounted for within an optimal theory of grammar?

In the work of Chomsky (1981, 1982) and many others, the two null elements are generally considered to be distinct. In Chomsky (1982), these two elements are called PRO and *pro*, respectively. PRO is assumed to be a pronominal anaphor, and *pro* a pure pronominal. The occurrence of PRO is presumably universal. Within each language the occurrence of PRO is limited to the subject position of a non-finite clause. This is assumed to follow from conditions A and B of Binding Theory of Chomsky (1981), namely from the 'PRO theorem' that it occurs only in an ungoverned position. The reference of PRO is assumed to fall under a separate theory of control.

The occurrence of *pro*, unlike that of PRO, is not universal across languages, English and French from example, do not allow a null subject within a finite clause. Languages like Italian and Spanish, on the other hand, allow a null subject within a finite clause. An important question that arises is then how to properly characterize the Pro-Drop or Null Subject Parameter. According to Chomsky (1981, 1982), the distribution of pro-drop is assumed, following Taraldsen (1978), to be determined by the principle of recoverability, or what Jaeggli (1982) terms the 'identification hypothesis'. The idea is that a pronoun may drop from a given sentence only if certain important aspects of its reference can be recovered from other parts of the sentence.

In a language like Italian or Spanish, the subject of a finite clause may drop, because the agreement marking on a finite verb is sufficiently rich to recover important aspects of, or determine, the reference of a missing subject. However, in a language like English, pro-drop is prohibited from the subject position of a finite clause, because its agreement markings are too meagre to sufficiently determine the reference of a missing subject. Furthermore, because the finite verb is marked only for agreement with the subject but not with the object, the identification hypothesis correctly predicts that no object may drop, either in the English type or in the Italian type of languages. The hypothesis also claims that if a language has a way of marking the verb with sufficient features of agreement with the object, pro-drop may also occur with the latter. This prediction is borne out by the 'split ergative' language Pashto. As indicated in Huang (1984), Pashto uses a split ergative system of agreement, requiring the finite verb to agree with the subject in some sentences, and with the object in others. The pro-drop facts of Pashto show that a subject or an object may drop just in case the verb is marked for agreement with it.

Year 2 familiar sociology text. From Giddens, A. (1993). *Sociology*. Polity Press, Oxford. (pp 230 - 231)

The view that class inequalities largely govern gender stratification was often an unstated assumption until recently, but the issue has now become the subject of some debate. John Goldthorpe has defended what he calls the 'conventional position' in class analysis - that the paid work of women is relatively insignificant compared to that of men, and that therefore women can be regarded as being in the same class as their husbands (Goldthorpe, 1983). This is not, Goldthorpe emphasizes, a view based on an ideology of sexism. On the contrary, it recognizes the subordinate position in which most women find themselves in the labour force. Women have part-time jobs more often then men, and tend to have more intermittent experience of paid employment because of withdrawing for lengthy periods to bear and care for children. Since the majority of women are in a position of economic dependence on their husbands, it follows that their class position is most often governed buy the husbands' class situation.

Goldthorpe's argument can be criticized in several ways. First, in a substantial proportion of households the income of women is essential to maintaining the family's economic position and mode of life. In these circumstances women's paid employment in some part determines the class position of households. Second, a wife's employment may strongly influence that of her husband, not simply the other way around. Although women rarely earn more than their husbands, the working situation of a wife may still be the 'lead'

Table A2.4 : Texts used in verbal protocols experiment - continued

factor in influencing the class of her husband. This could be the case, for instance, if the husband is an unskilled or semi-skilled blue-collar worker and the wife, say, the manageress of a shop.

Third, many 'cross-class' households exist, in which the work of the husband is in a higher class category than that of the wife, or (less commonly) the other way around. Since few studies of such households have been carried out, we cannot be confident that it is always appropriate to take the occupation of the male as the determining influence. There may be some purposes for which it is more realistic to treat men and women, even within the same households, as being in different class positions. Fourth, the proportion of families in which women are the sole breadwinners is increasing. Unless the woman has an income derived from alimony which puts her on the same economic level as her ex-husband, she is by definition the determining influence on her own class position (Stanworth, 1984; Walby, 1986).

Research supports the conclusion that the economic position of a woman cannot simply be 'read off' from that of her husband. A study carried out in Sweden showed cross-class families to be common (Leiuffsrud and Woodward, 1987). In most such cases, the husband had the superior occupation, although in a minority of instances the reverse was the case. The research showed that individuals in such families tended to 'import' aspects of their differing class position into the family. Decisions, for instance, about who stays home to care for a sick child were related to the interaction of class and gender in the family. Where the wife's job was superior to that of the husband, he would usually have this responsibility.

Year 2 unfamiliar sociology text. From Gilbert, N. (1993). *Researching Social Life*. Sage, London. (pp 87-88)]

Stratification involves dividing the population into separate strata on a characteristic assumed to be closely associated with the variables under study. A separate probability sample is selected from within each stratum. Building stratification into a sample design is recommended because it increases precision for very little additional cost. Stratification ensures that the sample is representative on the characteristic(s) used to form the strata.

A simple random sample will *on average* be representative of the population. However, any one sample may be quite unrepresentative on key characteristics. Suppose we want to study the career aspirations of university students and have sufficient resources to interview a sample of 125 students. Using simple random sampling, it would be possible to draw a sample which under-represents students from some departments, and over-represents others. Since career aspirations are likely to be closely linked to the subject studied at university, it is desirable that the sample should have the correct representation of the students' departments. This can be achieved be stratifying the sample using departments as separate strata.

Prior to sample selection, the sampling frame is divided into departments (strata). This is straightforward because lists of students by departments are available. Suppose the population consists of 5,000 university students and a sample of 125 is to be drawn. This would represent a 1/40 sampling fraction and a sampling interval of 40. The 5,000 students are listed by department and then systematic selection is used with a sampling interval of 40. A random start between 1 and 40 is selected, say 13. The 13th person in the first listed department is chosen, followed by the 53rd, 93rd, and so on.

Systematic selection from a list ordered by one or more stratification factors automatically forces the sample to be representative on these factors. In this example, the sample contains exactly the same proportion of students in the physics department as in the whole university, and similarly for each department. Another variable which is likely to affect career aspirations is students' year of study. The researcher could stratify both by department and by year within department, and this would yield a sample which was representative of students by department, by year of study, and by both variables in combination.

Stratification produces a lower standard error because the 'total variation' for any particular variable (such as career aspirations) in a population may be regarded as composed of variation 'between strata' and variation 'within strata'. In stratified random sampling, variation 'between strata' does not enter into the standard error because, by definition, this component of the variation in the population will be automatically reflected in the sample. The greater the proportion of a variable's 'total variation' that is accounted for by 'between strata' variation, the greater the gain in precision from stratification. For this reason, each stratum should be made as different as possible while maximising the similarity of elements within strata.

Table A2.4 : Texts used in verbal protocols experiment - continued

The estimation of sampling errors for stratified samples is more complex than for simple random samples. A stratified random sample will result in a standard error which is smaller than for a simple random sample of the same size. The relationship between the standard error of a complex sample design and that of a simple random sample of the same size is called the design effect, or Deff.

Year 3 version 1 familiar cognitive text. From Johnson-Laird, P.N. *Mental Models.* Harvard University Press: Cambridge, Mass. (pp 133-134)

The general theory of explicit inference based on mental models assumes that human reasoners can construct finite models of premises, formulate putative conclusions on the basis of them, and search for models of the premises that are counter-examples to such conclusions. If the search is systematic and exhaustive, then the conclusion is valid. But human reasoners often fail to be rational. Their limited working memories constrain their performance. They lack the guidelines for systematic searches for counter-examples; they lack secure principles for deriving conclusions; they lack a logic. Since even the most intelligent individuals have difficulty with certain syllogisms, and are aware of it, they have an obvious motivation to try to externalize and to systematize the search for counter-examples. Hence, the theory is compatible with the development of logic as an intellectual tool. When Aristotle invented logic, his method was to determine which pairs of syllogistic premises yielded valid conclusions. An inference of the form:

Every man is an animal
No stone is a man
∴ No stone is an animal

certainly yields a true conclusion. In order to determine whether inferences of this form were *valid,* Aristotle changed the content of the premises whilst holding their form constant, eg:

Every man is an animal
No horse is a man
∴ No horse is an animal.

The conclusion is manifestly false, but the inference is identical in form to the previous example. Since the form can lead to false conclusions from true premises, it must be invalid. Instead of searching for interpretations of premises that are counter-examples to conclusions, Aristotle held form constant and searched for premises with a content that was incompatible with the corresponding conclusion. He used his semantic intuitions to determine the set of valid syllogisms, and then he developed a logic - a set of principles for deriving validity.

A major advantage of natural mental models over other, more sophisticated, forms of representation such as Euler circles, Venn diagrams, and even the first-order predicate calculus, is that they can represent the content of any sentences for which the truth conditions are known. I shall illustrate this point by considering inferences based on relations and on different sorts of quantifiers. Relational expressions such *as greater than, father of, next to, equals, loves,* have a number of different logical properties. A relation such as *greater than* is transitive because it permits an inference of the form: if x is greater than y, and y is greater than z, then x is greater than z. In more general terms, the transitivity of a relation R guarantees the validity of an inference of the form:

xRy and yRz ∴ xRz

A relation such as *father of* is intransitive because it leads to the negation of *such a conclusion:*

xRy and yRz ∴ not (xRz)

A relation such as *next to* is neither transitive nor intransitive. A second set of properties concerns the symmetry of relations. A relation such as *next to* is symmetric because if x is next to y, then it follows that y is next to x. A relation such as *greater than* is asymmetric because if x is greater than y then it follows that y is *not greater than* x. A relation such as *not greater than* is neither symmetric nor asymmetric.

Table A2.4 : Texts used in verbal protocols experiment - continued

Year 3 version 2 familiar cognitive text. From Johnson-Laird, P.N. *Mental Models*. Harvard University Press: Cambridge, Mass (pp 370 - 371).

With the failure of story grammars to account for the structure of discourse, there is an obvious alternative hypothesis: a necessary and sufficient condition for discourse to be *coherent,* as opposed to a random sequence of sentences, is that it is possible to construct a single mental model from it (Johnson-Laird, 1980; Garnham, Oakhill , and Johnson-Laird, 1982). Coherence must be distinguished from *plausibility* since a discourse may be perfectly coherent yet recount a bizarre sequence of events. The possibility of constructing a single mental model depends on the principal factors of co-reference and consistency. Each sentence in a discourse must refer, explicitly or implicitly, to an entity referred to (or introduced) in another sentence, since only this condition makes it possible to represent the sentences in a single integrated model. Likewise, the properties and relations ascribed to referents must be consistent, that is, compatible with one another and free from contradiction. Plausibility depends on the possibility of interpreting the discourse in an appropriate temporal, spatial, causal, and intentional framework - a framework that, as Miller and Johnson-Laird (1976) argued, cross-classifies all semantic fields. When subjects generate approximations to discourse or reconstruct the order of a passage of prose, they make use of clues about both plausibility and co-reference.

The one substantial hypothesis about the organization of the knowledge underlying plausibility is the notion of a *script* (cf. Minsky, 1975; Schank and Abelson, 1977). A script represents the normal sequence of events in some relatively stereotyped activity such as dining at a restaurant. Schank and Abelson have written computer programs that both implement such scripts and use them in making inferences about stories. The possession of a script allows a speaker to leave many things unsaid with the certainty that the listener will be able to fill them in by default. For example, it is unnecessary to state explicitly that a customer in a restaurant eats the food that he has ordered. In accordance with the conversational conventions delineated by Grice (1975), it is only necessary to describe such untoward circumstances as, say, the customer refusing to eat his meal. If enough is said to elicit the appropriate script, then it can be used to fill in unspoken detail.

The main difficulty with the doctrine of scripts is that knowledge is also used to understand discourse about events that are *not* stereotyped. You can understand Kafka's *The Trial* without having a script for the persecution of an individual by an anonymous bureaucracy. Indeed, the novel is perhaps the original 'script' for all such encounters. Likewise, if I tell you a story about an aristocratic ski-instructor trying to get a permit to work in Oregon, I can rely on your general knowledge to support many inferences that do not derive from scripts. Schank (1980) is, of course, sensitive to these problems and to the need to account for the acquisition of scripts, but there is still much work to be done to explain the automatic and rapid retrieval of *relevant* information underlying the plausibility of a discourse.

The coherence of prose depends primarily on its pattern of co-reference. Narrative texts usually have a chain of co-reference linking one assertion to the next, whereas descriptive texts may have a series of references back to the same common topic.

Year 3 version 1 unfamiliar cognitive text. From Johnson-Laird, P.N. *Mental Models*. Harvard University Press: Cambridge, Mass (p206 - 208).

Some psychologists argue that words are represented in a mental dictionary that *decomposes* their meanings into semantic components. The origin of this idea is to be found in the linguistic theory of Katz and Fodor (1963). They assumed a version of the compositional principle, that is, the semantic interpretation of a sentence is obtained by replacing its words with their semantic representations. These representations are then combined according to the underlying syntactic structure of the sentence. They also held that the semantic representation of a word primarily comprises a structured set of elements, 'semantic markers' , which decompose its meaning into more primitive semantic constituents. Ultimately meanings are decomposable into a set of 'linguistically universal' and innate components.

Table A2.4 : Texts used in verbal protocols experiment - continued

If comprehension requires the meanings of complex words to be decomposed into their semantic constituents, then on the plausible assumption that this process should take time, the sentence 'A man lifts a boy' should be harder to understand (and perhaps occupy more space in memory) than 'An adult lifts a child'. However, there seem to be no such differences. Kintsch (1974) was unable to find any effects of semantic complexity on a number of measures, for example, the time taken to begin to speak a sentence containing a given word. Fodor, Fodor, and Garrett (1975) recorded the time taken to evaluate such deductions as "If practically all of the men in the room are not married, then few of the men in the room have wives". When the word *bachelor* occurred in place of *not married,* the inference was made reliably faster, and the improvement was greater than that created by a so-called morphological negative such as *unmarried.* These authors concluded that a word such as *bachelor,* unlike *unmarried,* does not contain a negative in its semantic representation - though it ought to, according to its definition. In another study Fodor, Garrett, Walker and Parkes (1980) failed to find any evidence for a complex representation of sentences with verbs, such as *kill,* which ought to contain a causal component.

Although the negative findings suggest that decomposition is not an inevitable part of comprehension, they may fail to convince sceptics. There is no reason to suppose that the latency to make up a sentence should be affected by the semantic complexity of words. Kintsch's other experimental tasks might not require a subject to decompose meanings even if that were part of normal comprehension. Consider, for example, the study in which the recall of a sentence (for example `John was accused of stealing`) was cued by a word denoting a relevant semantic component (for example *guilty*). Such a cue was no better than a close associate of a word in the original sentence (for example *blame).* This finding could be explained without giving up the idea of decomposition. For example, subjects may have drawn the inference that John was blamed for the theft. Likewise, Fodor, Fodor, and Garrett's conclusion - that the representation of *bachelor* does not include a negative - may not be justified by a mere difference in latency of response, as a negation in a dictionary entry might be responded to faster than a morphological or explicit negation. Fodor, Garrett, Walker and Parkes (1980) may also have used a task that failed to call for the semantic decomposition of words.

Year 3 version 2 unfamiliar cognitive text. From Johnson-Laird, P.N. *Mental Models*. Harvard University Press: Cambridge, Mass (pp 226 - 227).

We have seen that some words appear to be definable and perhaps to be primarily acquired from informal definitions, whereas other words are not definable and are thus likely to be acquired from ostensive definitions or from their use in context. The question that now arises is whether semantic information about a word is gathered together in a single entry in a mental lexicon or distributed throughout a set of independent meaning postulates.

Some theorists, such as Gibson (1971), have suggested that when a word is processed for meaning, all of its semantic components are necessarily recovered; others have argued that an exhaustive retrieval of a word's meaning is unnecessary (Fodor, Fodor, and Garrett, 1975). The evidence in the literature appeared to be equivocal. Some studies showed that the more classification tasks subjects carry out on a word, the more likely they are to remember it (e.g., Klein and Saltz, 1976; Frase and Kammann, 1974); other studies found no such effects (e.g., Hyde and Jenkins, 1969; Hyde, 1973). Graham Gibbs, Juliet de Mowbray and I were interested in how much of a word's meaning is recovered when it is processed and whether the amount of processing that is carried out on a word determines how likely it is to be remembered. The previous studies seemed unsatisfactory because they had often not used components of the meanings of words, and because they had often confounded the number of tasks carried out with the number of categories available to act as cues to recall. Hence, we used a task in which the subjects had to detect members of a target category in a list of words of various sorts. A target category was defined in terms of a number of semantic components, and the list contained words with all, some, or none of these components. For example, if the target category is defined to be consumable liquids, then *beer is* a member of it, *petrol* and *cake* have only one of the required components, and *coal* has neither of them. We assumed that the amount of relevant processing of a word in such a task determines its memorability, and that this variable is best indexed by the number of decisions about a word that yield pertinent information. If the different semantic components of a word can be processed separately, then a word with none of the target components requires assessment on only one of them in order to be rejected, while a word with several of the target components may require processing on a

Table A2.4 : Texts used in verbal protocols experiment - continued

number of components before it can be rejected. In general, the greater the number of components a word has in common with the target, the greater the amount of processing that it will require.

In our first experiment, the subjects listened to a list of thirty-six words and classified each of them as a positive or negative instance of a category defined on the basis of three components. The overall recall of the words on the list in an unexpected test was as follows: 57% of the target words, 45% of the words with two components of the target category, 34% of the words with one component of the target category, and 32% of the words with none of the target components.

Year 3 familiar emotion and stress text. From Strongman., K.T. (1987). *The psychology of Emotion*. Wiley: Chichester. (pp 106-107).

The major theoretical issue that must be addressed in any consideration of emotion- cognition relationships is whether or not they are linked at all. Is it reasonable to regard the two systems as independent? This is the central matter which the interesting debate between Zajonc (1980;1984) and Lazarus (1982; 1984) pivots upon. Amongst other things, Zajonc asserts that, not only does cognition not precede emotion, but also that emotion and cognition are independent, with emotion preceding cognition.

Lazarus argues that Zajonc's view is the result of seeing people as no more than computer-like information processors, instead of as sources of meaning. Personal factors colour the processing of experiences, nor do we have to have complete information before reacting emotionally to meaning. So, Lazarus asserts that there are no exceptions to the cognitive appraisal of meaning underlying all emotional states. This process might, however, be very rapid with thoughts and feelings being virtually instantaneous. Part of the problem in this debate is definitional, if the idea of emotion is pushed far enough it appears to bang up against cognition, similarly, if cognitive processes are followed far enough they appear to reach emotion. If, in the end, either one is defined in terms of the other, the question of which precedes which becomes meaningless.

Kiesler (1982) suggests that one of the difficulties in conceptualizing the emotion-cognition relationship is that the empirical areas it embraces overlap, but not exactly. He argues that there is such a large range of emotional reactions that although the simple ones may be without cognitive content or cognitive instigation, the more complex ones must involve them. Kiesler attempts to argue in support of both sides of the debate. He suggests that the data provided by Zajonc fit with the idea of two partly independent systems, without ruling out the possibility that there is only one. In fact, both Zajonc and Lazarus offer powerful arguments, but it is Lazarus's view that is finally the more compelling of the two. It is difficult to conceive of emotion without cognition, even though the two systems might be independent as well as interacting.

It was mentioned in the last section that we do not need access to full information before reacting to emotional meaning. This idea suggests the importance of an analysis *of* preconscious processing to an understanding of the links between cognition and emotion. The emotional aspects of preconscious processing are most cogently discussed by Dixon (1981). He points out that many studies in this area have used emotional responsiveness as a dependent variable because many of the correlates of emotional arousal are outside voluntary control and so provide a useful measure of subliminal effects. Also, emotional processes could give a useful clue to the need related government of the preconscious processing of perception and memory. The basic question he poses is whether the emotional connotations of external stimuli can be reacted to without conscious representation, and if so, what influence might this have? Dixon points to a considerable body of evidence which confirms the original subception effect of the emotional components of stimuli being reacted to autonomically before they are consciously recognized. The various theories which have been offered to account for this effect have in common the notion that preconscious autonomically based emotional disturbance affects both verbal report and perceptual processes.

Year 3 unfamiliar emotion and stress text. From Changing moods p73

Most explanations of mood incongruence emphasize indirect influences for the obvious reason that it would seem self-contradictory to claim that mood led *directly* to effects implying evaluations opposite to those inherent in the affective state itself. One of the most important mediating factors in determining indirect mood effects concerns mood awareness (cf. Morris, 1989). In other words, the degree to which we are conscious of our present mood makes a difference to the way it influences our thought, feelings, and action. Although it can be argued that the presence of mood always colours conscious experience, we are not always explicitly aware that we are in a particular kind of mood (Frijda, 1986). For example, some of our own recent research suggests that mood often only becomes salient at relatively high levels of intensity. When mood enters reflective consciousness then it begins to exert cognitive effects that may be superimposed upon its direct influences. These effects are indirect because they depend on the way mood is represented, and not simply on mood itself.

One of the reasons why consciousness may lead to different mood effects is that it changes the way the relevant information is processed. A useful distinction in this regard is between *controlled* and *automatic* processing (Shiffrin &: Schneider, 1977). Direct and unconscious effects of mood are likely to be *automatic,* meaning that they require little cognitive capacity, are relatively unresponsive to alternative demands on resources, and are more difficult to control deliberately. In contrast, indirect effects of mood mediated by conscious awareness presumably depend on *controlled* deliberate processing. This involves relatively high levels of attention and draws heavily on cognitive resources. When people are aware of their moods, then, mood information is more likely to play an explicit role in their reasoning processes. However, the controlled use of this information will also decrease the cognitive capacity that remains for use on other subsidiary tasks. Thus, there are both benefits and costs associated with controlled processing of mood information.

An example of how mood may exert both conscious/controlled/indirect and unconscious/automatic/direct effects is provided by considering how people react to unpleasant moods. In this regard, Isen (e.g., 1984) has argued that people often make concerted attempts to dispel any unpleasant mood that enters awareness, using *mood-repair strategies* of various kinds. The result of this may be that any automatic mood-congruence effects are counteracted by controlled processing that is selectively directed at positive aspects of the situation and intended to alleviate unpleasant feelings. Thus, when in a bad mood, people may automatically become attuned to unpleasant features of what is happening but may also simultaneously try to look on the bright side of events with the explicit intention of getting themselves out of the bad mood. Of course, not all indirect effects of mood depend on controlled processing of this kind. For example, being in a pleasant mood may automatically attune you to pleasant aspects of the situation. Your positive response to these features may affect other people's interpretations and reactions to you, which in turn influence your subsequent action and so on. When mood is considered in its everyday interpersonal context its indirect effects may stretch out almost indefinitely over time.

Year 3 familiar vision text. From Howard. I.P. (1982). *Human Visual Orientation*. John Wiley & Sons Ltd. Chichester, NY. (pp 60-62).

Campbell and Robson (1968) suggested that the visual system behaves, not as a mechanism with a single broad-band spatial filter common to all receptors, but as a mechanism with a number of independent channels, each tuned to a particular band of spatial frequencies. In support of their suggestion they produced psychophysical evidence, and they cited physiological evidence of Enroth-Cugell and Robson (1966) that the contrast-sensitivity functions of individual ganglion cells of the cat are narrower than the overall contrast-sensitivity function. It seems therefore that spatial-frequency tuning begins in the retina. Campbell et al (1969) later recorded from simple cells in the visual cortex of the cat and found that these cells are not only selectively responsive to the orientation of the stimulus, but also to its spatial frequency. Movshon et al (1978c) determined the spatial-frequency characteristics of cells in areas 17 and 18 of the cat's visual cortex. The range of preferred spatial frequencies for cells in area 17 was 0.3-3 cycles/deg, and their spatial-frequency bandwidth (at half amplitude) varied from 0.7 to 3.2 cycles/deg. The most common bandwidth was approximately 1.3 octaves. Simple and complex cells did not differ significantly in these respects. However, the preferred spatial frequencies of complex cells in area 18 were much lower than those of complex cells in area 17. Movshon et al speculated that this difference might be due to a predominance of direct Y cell inputs to complex cells in area 18 of the cat's visual cortex.

Psychophysical evidence has accumulated which supports the idea that the visual system has separate spatial-frequency channels. A grating with a square luminance profile may be synthesized by superimposing

Table A2.4 : Texts used in verbal protocols experiment - continued

a series of sine-wave gratings, one with the same frequency as the fundamental frequency of the square-wave grating and one at each higher odd harmonic of that frequency. The component gratings must be arranged in proper relative phase and their luminance contrasts must decrease in proportion to their increase in spatial frequency.

The psychophysical evidence that Campbell and Robson (1968) produced in support of their original suggestion that the visual system has several spatial-frequency channels was, essentially, that a complex grating pattern, such as a square-wave grating, becomes visible when the contrast of the fundamental component reaches the threshold of an isolated sine-wave grating with the same spatial frequency. However, as Furchner et al (1977) have pointed out, this evidence is not conclusive. Consider a 5 cycle/deg square-wave grating, the lowest harmonic component is 15 cycles/deg, which has a contrast of only one-third that of the fundamental, and, in any case, the visual system is less sensitive to sine-wave gratings of 15 cycles/deg. It is not surprising that the visibility of a square-wave grating at threshold luminances is determined only by the fundamental component. This would be true whether or not the visual system had distinct spatial-frequency channels. The situation is different for low spatial-frequency square-wave gratings, for instance, for a square-wave grating of 0.25 cycle/deg, the lowest harmonic is 0.75 cycle/deg. Although this component has only one-third the contrast of the fundamental, the visual system is about three times more sensitive to it than to the fundamental, so that the lowest harmonic is just as likely to affect the visibility of the square-wave grating as is the fundamental.

Year 3 unfamiliar vision text. from Howard, I.P. (1982). *Human Visual Orientation*. John Wiley & Sons Ltd. Chichester, NY. (pp 530-531).

A basic task within the domain of orientation of shapes in the plane is that of responding in characteristic ways towards a shape in a particular orientation, or towards a pair of shapes which have a particular relative orientation or a particular orientation of the intershape axis. This task may be called *identification or recognition of orientations.* The subject must not merely say whether the orientations of two stimuli are the same or different, he must respond in a distinct and consistent way to each of at least two different members of the stimulus set which he is shown.

One type of identification response consists of pairing a particular orientation with a particular stimulus of an entirely different kind. For instance, the subject may be asked to place each object with a particular orientation into a separate distinctly coloured box. But he must not be allowed to see the contents of the boxes because, if he were, he could perform the task by matching orientations. For the same reason, the 'labels' on the boxes must be neutral with respect to the orientation of the shapes, and the boxes must not be spatially arranged in a way that relates to the orientation of the stimuli. Another type of identification response consists of pairing a particular orientation with a particular response that the subject executes. For instance, the subject may be asked to give a name to each orientation. But not all differential responses qualify as identifying responses. Consider the case where a person points in the direction of an arrow when it is in different orientations. It can be said that he has learned to differentially respond to different orientations, but really all we know is that he can match the orientation of his hand to that of the object: we do not know whether he can identify the orientations that he has matched. This type of differential responding is really an act of distinguishing between orientations. To prove that a person has identified an orientation, he must make differential responses which are not spatially related to the stimuli. For instance, if a person says 'left' when a pattern faces left and 'right' when it faces right, we have grounds for saying that he has identified the orientations of the pattern, because the words 'left' and 'right' are not intrinsically related to the stimuli.

The task of saying whether or not a stimulus is in the same orientation as another stimulus presented at the same time is not an identification task. Even if the first stimulus is removed before the second stimulus is presented, the task of saying whether or not they have the same orientation would still not be one of Identification, unless the subject has to remember which of several previous stimuli the present stimulus resembles. If there are several absent comparison stimuli it is an identification task, because the subject has to pair a particular orientation with a distinct non-spatial aspect of the comparison stimulus, namely, the identity of the comparison stimulus selected from memory. If a person merely says that he has seen a shape in this particular orientation before, this could be called an identification because he has attached a specific response to a set of orientations that are equivalent with respect to having been seen before.

Table A2.4 : Texts used in verbal protocols experiment - continued

Year 3 familiar health text. From Tew. M. (1990). *Safer childbirth*. Chapman & Hall, London. (pp 248- 250).

Baird's policy of intervention was aimed at preventing the deaths of mature fetuses. Even if successful, this would not have caused a great reduction in the overall perinatal mortality rate, for such fetal deaths made up a relatively small proportion of the total. Making up by far the largest proportion were the deaths of premature and low-weight fetuses and babies. These he attributed to environmental causes, not remediable by intranatal interventions. Moreover, there was evidence that care in obstetric hospitals reduced their chances of survival. In the 1958 survey, the perinatal mortality rates for births with gestations of less than 38 weeks and for births weighing less than 2500 grams were much the highest for actual deliveries in hospital and were highest also for hospital-booked deliveries. The survey evidence was consistent with that on low-weight births collected by the Chief Medical Officer of the Ministry of Health and published in his *Annual Reports* between 1954 and 1964. This showed that the rate of stillbirths plus neonatal deaths was always very significantly higher when delivery took place in NHS hospitals, in which category GPUs were then included, than when it took place at home, with which were included the small number in private nursing homes. This was so even although the home figure included the neonatal deaths of sick babies transferred to hospital.

After 1964, the Chief Medical Officer ceased publishing this information, but his office continued to collect it and copies of the raw detailed data relating to the years 1967-73 were supplied privately to the present author on her request. From these it was possible to calculate mortality rates at specific birthweights. The results showed that for births weighing up to 1500 grams, place of delivery made no significant difference to the chance of surviving the neonatal period. At all heavier weights this chance was significantly less if delivery took place in hospital. These results were publicly known until 1964 and thereafter privately known to officers in a strong position to influence the direction of policy. Supportive as they were of the true results of the 1958 survey, they should have diverted policy in the opposite direction from that being insistently urged by obstetricians in the 1960s. That they were not used in this way illustrates the degree of power and persuasion obstetricians had come to exercise over medical colleagues at the highest level. It must be a matter of speculation on what grounds publication of this enlightening but politically embarrassing material was discontinued. However, even while it was published, its significance was ignored or dismissed and the policy of hospitalization was unwaveringly pursued. After 1970 births at home were being so drastically reduced in number that they were rapidly ceasing to be a representative cross-section of normal mothers and the associated mortality rate was rapidly ceasing to be a fair proxy for the results of low interventive midwifery care.

In 1970 the second national survey of perinatal mortality was carried out under the same auspices and using the same method of enquiry as the survey in 1958. This time it was concerned, not only to examine the associations of death at and around delivery, but also to follow up live-born children and their mothers for a week after birth.

Year 3 unfamiliar health text. From Stroebe, W. & Stroebe, M.S. (1987). *Bereavement & Health*. Cambridge: Cambridge University Press. (pp 163-165)

The National Center for Health Statistics (NCHS) in 1970 published one of the most detailed accounts of cross-sectional evidence on the causes of death for different marital status groups. This report presents information on the leading causes of death for the married and the widowed. It is interesting to note that the rank order of the three leading causes of death is identical for married and widowed persons. Coronary heart disease is the major killer, followed by strokes, and then cancer of the digestive organs and peritoneum. The picture changes, however, if one inspects ratios in widowed-to-married mortality rates for specific causes of death in order to identify those causes which show the greatest *excess* for the widowed. The NCHS (1970) published standardized marital status-mortality ratios for white women and men on a number of cases of death. The NCHS used U.S. rates for the years 1959-1961. If one rank-orders these ratios according to magnitude, it becomes evident that the two leading causes of death (arterio-sclerotic heart disease, including coronary heart disease and vascular lesions of the nervous system) do not show the greatest excess. In widows coronary heart disease and vascular lesions rank behind violent causes of death (accidents, suicide, and homicide). In widowers, they are even preceded by homicide, liver cirrhosis, suicide, accidents (motor vehicles and others), and tuberculosis; and closely followed by the various forms of cancer, which are also excessive in the widowed.

However, the magnitude of widowed over married excess for a given cause of death is frequently quite unrelated to the relative contribution of that cause to the overall widowed-to-married difference in mortality. Widowed-to-married excess is expressed as a ratio of widowed-to-married rates of mortality due to a given cause of death. Therefore, rare causes of death, if they are affected by stress, are more likely to become excessive than causes such as coronary heart disease or cancer, which have a very high base rate in the general population. Hence, if one is interested in assessing the relative contribution of each cause to the overall widowed-to-married difference in mortality, the widowed-to-married *difference* in mortality due to this cause should be considered. The excess mortality of widowers from homicide, liver cirrhosis, and suicide is more than twice that of married men. Thus these three causes contribute very little to the overall widowed-to-married difference in mortality. For example, in 1959-1961 only 56 widowers per 100,000 died from tuberculosis. In contrast, 3,171 died from coronary heart disease. Since tuberculosis is even rarer in married individuals, it outranks cardiovascular disease when standardized marital status-mortality ratios are considered. However, despite its smaller widowed-to-married ratio, cardiovascular diseases account for a much greater share of the overall widowed-to-married difference in mortality.

One would expect that mortality from cardiovascular diseases should be even more excessive in longitudinal studies than when cross-sectional data are considered. Although we assume that bereavement merely aggravates or accelerates existing disease processes, a myocardial infarction is a faster-acting cause of death than tuberculosis, liver cirrhosis, or cancer. Thus, in a longitudinal study of the recently bereaved, coronary disease should be a more excessive cause of death than in cross-sectional samples where individuals have typically been widowed for several years.

Year 3 familiar biology text. From Roitt, I.M., Brostoff, J. & Male, D.K. (1995). *Immunology.* Ch 6 The generation of diversity. Gower Medical: London. (p9.1).

Antibodies are remarkably diverse; not only must they provide enough different combining sites to recognize the millions of antigenic shapes in the environment, but also each class of antibody has a different effector region. For instance, IgE can bind to Fc receptors on most cells whilst IgG can bind similarly to phagocytes. It has been estimated that an individual produces more different forms of antibody than all the other proteins of the body put together. Looked at another way, we produce more types of antibody than there are genes in our genome. How then can all this diversity be generated? Ideas about the formation of antibodies have changed considerably over the years. However, it is, perhaps, surprising how close Ehrlich came with his side chain hypothesis at the beginning of this century. His idea of antigen-induced selection is close to our present view of clonal selection except that he placed several different receptors on the same cell.

Ehrlich proposed that the combination of antigen with a preformed B Cell receptor (now known to be antibody) triggered the cell to produce and secrete more of those receptors. Ehrlich thought a single cell could produce antibodies to bind more than one type of antigen. However, it is evident that he anticipated both the clonal selection theory and the idea that the immune system could generate receptors before contact with antigen. After Ehrlich the situation became complicated. The problem was that many new organic chemicals were now being synthesized. Also Landsteiner was showing that the immune system could react with the production of specific antibody for each new compound. It was simply not thought possible that the immune system could have maintained, by natural selection, genes for all these anti-bodies directed at novel, artificial compounds. This led to the development of the instructive hypothesis which suggested that a flexible antibody molecule is induced by antigen to form a complementary binding site. There have been three major hypotheses explaining the generation of antibody diversity. The first major hypothesis is the instructive hypothesis: antigen encounters a pluripotent immunoglobulin molecule (P) which assumes a shape complementary to the antigen (P'). The second major hypothesis is the selective hypothesis: the antigen encounters a variety of different immunoglobulins generated by the immune system *(A, B, C);* only one of which fits the antigen. Only the cells producing this type of antibody respond to the antigen's stimulus. The instructive hypothesis was discarded since it is now known that changes in protein structure cannot be translated into changes in the DNA, which is necessary to retain the alteration of P' during clonal proliferation. The third major hypothesis is the directive hypothesis: which also envisaged antigen generating the molecules necessary to recognize it, but suggested that this occurred directly at the DNA level. This hypothesis has also been discarded in favour of the selective theory. With the spectacular progress in molecular biology in the 1950s and 60s the instructive hypothesis became untenable. The circle turned, and selective theories came back into favour with Jerne and Burnett independently putting forward the idea of clonal selection. Each lymphocyte produces one type of immunoglobulin only, and the antigen selects and stimulates cells carrying that immunoglobulin type.

Year 3 unfamiliar biology text. From Roitt, I.M., Brostoff, J. & Male, D.K. (1995). *Immunology*. Ch 18. Immunity to Tumours. Gower Medical: London. (18.1).

Solid human tumours removed at surgery are sometimes characterized by a marked mononuclear cell infiltrate. This characterization is unrelated to tissue necrosis, which suggests a host resistance of an immunological nature. Modern enzyme immunohistochemical techniques reveal that such infiltrates are heterogeneous and frequently comprise mononuclear phagocytes; lymphocytes of different subtypes; as well as minority populations of other cells (such as plasma cells and mast cells). In man, the opportunity to monitor the *in situ* immune responses usually arises only once; at surgery for removal of the primary lesion. This reflects the situation at an isolated, often very late point in the pathogenesis of the tumour. For some rare neoplasms mononuclear cell in-filtration is a good indicator of prognosis (for example, in medullary carcinoma of the breast) and may even contribute to conventional anti-cancer therapy (for example, in seminoma of the testis). However, there is no simple relationship between infiltration and prognosis and/or survival. The view that mononuclear cell infiltration has a defensive connotation is therefore an assumption. Although the *in situ* function of these cells is not determined, their presence does suggest an involvement of cells of the immune system with established cancers. This therefore has important implications for the host response to the disease at earlier stages.

Many experimentally induced neoplasms are characterized by mononuclear cell infiltrates. For some, for example, Moloney virus-induced sarcomas, host cell infiltration is clearly associated with the frequent spontaneous regression of this tumour. This neoplasm is probably unique in this respect and its biological behaviour has little relevance for human neoplasia. For the majority of tumours - clinical and experimental - the relationship is much more complex. Malignant transformation may be accompanied by phenotypic changes in the involved cells. For example, the loss of normal cell surface antigenic components; gain of neoantigens (antigens not detectable in the corresponding normal tissue); and other membrane changes which influence cell:cell interactions in the host. Whether 'public' (that is, expressed on cells other than the tumour) or 'private' (that is, expressed exclusively by the tumour), some of these neoantigens are capable of evoking an adaptive immune response.

In some systems, the immune response to these antigens may be as strong as an allogeneic reaction. At the other end of the spectrum, tumours which show minimal anti-genic changes might be expected to elicit little or no adaptive immune response. (Spontaneous tumours of experimental animals are the major group in this category.) Between these two extremes lie the theoretical possibilities that tumours express neoantigens which evoke no response at all, or generate a response which is success-fully evaded. This condition is referred to as 'immunological escape'. While neoantigens appear to be a stable, heritable property of some selected experimental tumours, the majority of cancers should probably be regarded as heterogeneous, genetically unstable and subject to phenotypic change. In addition to changes in the antigenic phenotype of malignant cells, tumour cell membranes apparently acquire new 'structures' which render them susceptible to natural effector cells. The relationship of these structures, which are present in a wide variety of tumour cells, and the well-defined cell surface antigens is presently unknown. The adaptive immunity induced to tumour antigens is essentially similar to that evoked against T cell dependent transplantation.

Year 3 familiar computer science text. From McDermid, J. (1993). *Software engineers reference book*. Butterworth-Heinemann: Oxford (pp 41 - 42)

To enable reuse, the specification should give a clear statement of the theory and concepts underlying the software, independent of any particular implementation. Even for code, its reuse must be mediated by the existence of specification and design descriptions of the code, which are then used during the early stages of development and ensure the correct incorporation of the code. However, the existence of suitable implementations of the component are not necessary for the successful reuse of the component. Freeman (1983) reiterates this point more strongly, claiming that the reuse of program code alone is of negligible value, and arguing that such an emphasis is inconsistent with the exhortation to put more effort into the analysis and design activities.

Reuse of existing software presents a problem if it is only available as code. One solution is provided by retrofitting specifications to such systems. This strategy has been characterized as re-engineering (Arnold, 1986; Swift, 1987; Sneed and Jandrasics, 1989). Much existing software (so-called 'dusty decks', alluding to its historical origins in the days of punched cards) lacks any systematic documentation from requirements analysis through to specification, design and implementation, although there may be rudimentary documentation describing the software's operational usage. Such software may have evolved over a number of years, and no records may exist of its maintenance and enhancement. However, it may be that within the organization responsible for such ancient software, there are local experts well versed the 'folklore' of a particular software system or program. Codifying the expertise of these practising programmers is a first step towards salvaging such software for reuse. This may have the added benefit of leading to the rediscovery of old or lost ideas. In retrofitting a specification to an existing implementation, it is necessary to identify and abstract away from design and implementation decisions. The more abstract specification obtained will allow more flexible reuse of the software.

This reverse engineering, necessary to extract reusable components from existing code, still requires a lot of research. Possibly the most promising approach so far comes from the Programmer's Apprenticeship project at MIT (Waters, 1988), where standard 'cliches' or patterns are searched for in the code, thus systematically identifying the design strategies that had been used, enabling us to abstract higher level descriptions of the software. Alternatively, we could intend only to exploit reusable software when developing new software. This still requires us to be able to identify elements of software that are potentially reusable, and cast them in a sufficiently general form to enable wide reuse. We would then focus extra effort on developing the new reusable parts, to maximize the cost and quality benefits derivable from the reuse of these parts. In all cases it is essential to create as general a component as possible, while avoiding over-generalization which could make specific uses difficult to instantiate, and inefficient in operation. This requires that generalizations and inductions are made over several more specific components, a process for which no general guidance is available as yet.

Having identified software which is potentially reusable and described it in such a way that anyone wishing to reuse it would be able to do so, the problem arises as to how to organize the total collection of all such software and related descriptions.

Year 3 unfamiliar computer science text. From Pahl, G. & Beitz, W. (1988). *Engineering Design*. The Design Council: London. (pp 23-24).

In order to solve a technical problem we need a system with a clear and easily reproduced relationship between inputs and outputs. In the case of material conversions for instance, we require identical outputs for identical inputs. Also, between the beginning and the end of a process, for instance filling a tank, there must be a clear and reproducible relationship, and this relationship must always be planned - that is, designed to meet a specification. For the purpose of describing and solving design problems it is useful to apply the term *function* to the general input/output relationship of a system whose purpose it is to perform a task.

For static processes it is enough to determine the inputs and outputs; for processes that change with time (dynamic processes), the task must be defined further by a description of the initial and final magnitudes. At this stage there is no need to stipulate what solution will satisfy this kind of function, and the function thus becomes an abstract formulation of the task, independent of any particular solution.

If the *overall task* has been adequately defined - that is, if the inputs and outputs of all the quantities involved and their actual or required properties are known - then it is possible to specify the *overall function*. An overall function can often be divided directly into identifiable sub-functions corresponding to sub-tasks. The relationship between sub-functions and overall function is very often governed by certain constraints, in as much as some sub-functions have to be satisfied before others. On the other hand it is usually possible to link sub-functions in various ways and hence to create variants. In all such cases, the links must be compatible. The meaningful and compatible combination of sub-functions into an overall function produces a

Table A2.4 : Texts used in verbal protocols experiment - continued

so-called *function structure*, which may be varied to satisfy the overall function. To that end it is useful to make a block diagram in which the processes and sub-systems inside a given block (black box) are at first ignored.

Functions are usually defined by statements consisting of a verb and a noun, for example 'increase pressure', 'transfer torque' or 'reduce speed'. They are derived from the conversions of energy, material and signals. So far as is possible, all these data should be accompanied with specifications of the physical quantities. In most engineering applications, a combination of all three types of conversion is usually involved, with the conversion either of material or of energy influencing the function structure decisively. It is useful to distinguish between *main* and *auxiliary functions;* while *main functions* are those sub-functions that serve the overall function directly, *auxiliary functions* are those that contribute to it indirectly. They have a supportive or complementary character and are often determined by the nature of the solution. These definitions are derived from value analysis and are not identical for all levels of approach. While it may not always be possible to make a clear distinction between main and auxiliary functions, the terms are, nevertheless, useful.

In systematic work it is helpful to exploit certain general characteristics of human thought. Hollinger distinguishes between unconscious, preconscious and conscious thought, and prescribes the transformation of aimless and unconscious procedures, and of disorderly and fantasy-charged preconscious procedures into a *conscious* or *deliberate* approach.

Year 3 familiar economics text. From Solomon. L.M., Walther, C.M., Plunkett, L.M. & Vargo, R.J. (Eds). (1993). *Accounting Principles*. West Publishing Company, Minneapolis. (pp 504-505).

A key assumption in accounting is that a business will continue to operate for an indefinite period of time unless there is substantial evidence to the contrary. Stated differently, the business is presumed to be a going concern. Even though all entities do not survive, the going-concern assumption is valid in the majority of cases and forms the basis for many accounting practices. For example, if we expected a business to terminate in the near future, items such as land and equipment would be expensed upon acquisition because of a low probability of receiving benefits beyond the current period. These resources, of course, are treated as assets. The going-concern assumption also provides some justification for the use of an accounting system based on historical cost. Should a company plan to cease operations in the near term, asset valuation on the balance sheet could properly take the form of liquidation (sale) prices in view of the assets' impending disposal. Although a business is assumed to conduct operations for long periods of time, investors, creditors, governmental authorities, and other financial statement users cannot wait forever to analyze performance. The periodicity assumption holds that for reporting purposes, an entity's life can be divided into discrete time periods such as months, quarters, or years. As a result of this assumption the accountant must assign business transactions to specific reporting periods. In many cases this task presents no special problems. For example a check written on March 1 in payment of March rent is easily traced to March.

Difficulty arises, however, when dealing with expenditures that span several periods. To illustrate, consider a long-lived machine. If a company wants to produce a yearly income statement, the machines cost must be allocated to the period in question via depreciation expense. Depreciation can be computed (and cost allocated) by several acceptable methods, each producing different results. Most accountants recognize that cost allocations normally result in arbitrary figures, thus diminishing the usefulness of financial statements. Aside from depreciation, the periodicity assumption also forms the basis for amortization and the adjusting process at the conclusion of an accounting period. All countries have a unit of exchange. The United States uses the dollar; Mexico, the peso; and Japan, the yen. Business organizations adopt the National currency of their home country to quantify financial activity. Accounting therefore assumes that an entity's transactions can be expressed in terms of a common measuring unit, namely, money. If all organizations in a given country use the same measure, or monetary unit, extensive comparative analysis by financial statement users is possible.

Financial reporting in the United States is based on the premise that the dollar is a stable evaluation unit, thereby permitting dollars of different years to be combined in the financial statements. When computing the balance in a company's Land account, for instance, land transactions of the l990s are mixed with transactions that occurred in prior years. This calculation is reasonable provided that the dollar is, in fact, stable. Historically, accounting policy makers have taken the position that fluctuations in the value of the dollar are small and can be ignored. However, some accountants contend that transactions occurring today cannot be combined with those of earlier periods. The net result would be the combination of dollars of different purchasing powers, and hence, misleading financial statements.

Year 3 unfamiliar economics text. From Drury. C. (1992) *Management and cost accounting.* (3rd Ed). Chapman Hall, London. (pp 807).

Practitioners have shown an enormous amount of interest in activity-based costing. There has been a surge in the number of delegates attending courses and conferences on this topic, and much interest has been generated by articles in the professional accountancy journals. This would seem to suggest that practitioners are dissatisfied with traditional product costing systems. It is therefore likely that many firms will implement activity-based systems in the next decade. The survey by Drury *et al.* (1992) reported that 3% of the firms had implemented ABC, 9% intended to implement it and a further 38% were considering including it.

ABC has attracted considerable interest because it provides not only a basis for calculating more accurate product costs, but also a mechanism for managing costs. It is in the area of cost management and cost control where ABC may have its greatest potential. Thus the scope of activity costing has widened to incorporate budgeting and responsibility accounting, and it is likely that greater emphasis will be placed on managing the business on the basis of the activities that make up the organization. Those firms that implement ABC systems are likely to maintain two systems: one for external financial accounting and preparing monthly profit statements using traditional product costing systems, and a separate ABC system for strategic decisions. For financial accounting purposes *individual* accurate product costs are not required, since the objective is to provide a reasonable approximation of the allocation of costs between cost of goods sold and inventories at the *aggregate* level. Therefore simplistic cost systems can be operated for financial accounting using standard costing where manufacturing operations are repetitive. The detailed tracking of costs is unnecessary for decision-making purposes. Product costs for decision-making should be reviewed periodically (say once or twice a year). A cost audit should be undertaken to ascertain, once in a while, the cost of a product. The cost audit should generate product costs derived from an ABC system. The cost of operating an ABC system to continuously track costs through the system to value stocks and prepare monthly profit statements is likely to be excessive. It is therefore likely that activity-based costs will be used for periodic cost audits and traditional standard costing (or backflush costing) systems for external financial reporting and preparing monthly profit statements.

The potential of management accounting systems to support the strategies of an organization is now being recognized. Identifying cost drivers and tracing costs to products on the basis of cost driver consumption has the potential for influencing managerial behaviour. Hiromoto (1991) illustrated how a Japanese company used cost drivers to implement a policy of parts standardization as one component of a cost reduction strategy. The manufacturer identified the number of part numbers as its key cost driver, or strategic behavioural cost driver, to implement the chosen strategy of standardizing and reducing parts, simplifying the manufacturing process and decreasing manufacturing costs. Management devised a method of allocating manufacturing overhead so that product costs increased with the number of parts used and with the number of non-standard parts used. The standardization rate (number of common parts/total number of parts) increased steadily, despite increasing product variety, from 20% in 1978 to 68% in 1987.

Year 3 familiar english language text. From Atkinson. M. (1992) *Children's syntax.* Blackwell Publishers: Oxford. (pp 22 - 23).

One of the earliest achievements of the approach to linguistics inspired by Chomsky was to demonstrate the descriptive poverty of the methodologically guided structuralist approach. With this demonstration came the insistence that the child approaches language acquisition equipped a priori with knowledge about the general form of language. This a priori knowledge is, from our perspective, nothing more than a specification of a hypothesis space which simultaneously delimits the child's options as far as language acquisition is concerned and also makes such acquisition possible. What should the hypotheses comprising the hypothesis space consist of? In the simple illustrations of the Gold paradigm we have considered, these have been languages, construed as sets of sentences, but as soon as we take seriously the view that the hypothesis space is mentally represented in the child, the inappropriateness of this suggestion is apparent. To see this, we have only to consider what we are committed to when we assert that someone is a speaker of English. From a mentalist perspective, we obviously wish to identify this condition with the person being in a certain mental state. However the content of this mental state does not correspond to a listing of all the possible sentences in English. The number of sentences in any natural language is infinite and minds, ultimately brains, have finite capacities. To see the child, embarking on language acquisition, as initially provided with a set of (infinite) sets of sentences is, if anything, even more bizarre.

Indeed, identifying English with a set of sentences is itself a somewhat dubious strategy if we adopt Chomsky's view (1980, 1986a) that languages, understood in this way, are epiphenomenal and not amenable to scientific investigation. Chomsky (1986a) distinguishes E-languages from I-languages, the former being sets of sentences, somehow construed, with the 'E' suggesting 'external', and the latter corresponding to systems of mental representation, the 'I' indicating 'internal'. He says:

> The technical concept of E-language is a dubious one . . . Languages in this sense are not real-world objects but are artificial, somewhat arbitrary, and perhaps not very interesting constructs. In contrast, the steady state of knowledge attained and the initial state S_O [what we are here calling the initial hypothesis space - MA] are real elements of particular minds/brains......

Thus, I-languages constitute the proper domain for scientific linguistic study. What, then, are we to make of the claim that someone is a speaker of English? This now becomes a sociopolitical assertion which could be recast as follows: the person in question has an internal system of representation (an I-language), the overt products of which (utterance production and interpretation, grammaticality judgements), in conjunction with other mental capacities, are such that that person is judged (by those deemed capable of judging) to be a speaker of English. From this perspective, it is, of course, natural that individuals with different I-languages can be judged to be speakers of the same E-language, a situation which should give rise to no puzzlement. Returning, then, to our question of what a speaker of English mentally represents, it is an I-language, or, in more traditional terminology, a *grammar.* If this appears an appropriate answer for this question, it also provides the basis for an answer to the question about the initial hypothesis space.

Year 3 unfamiliar english language text. Ingram. D. (1994). *First Language Acquisition. Method, Description and Explanation.* University Press, Cambridge (p 240 - 242).

The fact that successive single-word utterances come to refer to one context as well as sharing acoustic properties has been used by some investigators as evidence that these sequences share a common grammatical structure (e.g. Scollon, 1976; and Ingram, 1979b). The proposal is something like this. During the period of single-word utterances, the child begins to have some rudimentary understanding of the grammatical structure of the adult language. There is little evidence of understanding syntactic structure, but there is some indication that some semantic relations are understood. During at least the latter part of this period, this knowledge underlies the child's single-word utterances. For example, the child who says 'cow' in referring to picking up a toy cow may be using that with the underlying structure of Action + Object. Later, holistic sequences are further expressions of this same semantic structure. The child at this point may say the sequence 'up' 'cow' in the same context. Later still, a multiword utterance such as 'up cow' will also reflect this knowledge.

This viewpoint is what has come to be known as a *rich interpretation* of single-word utterances. It has been argued for in Ingram (1971), Greenfield and Smith (1976), and Scollon (1976), among others. Scollon (1976) has used the terms 'vertical construction' and 'horizontal construction' to discuss this issue. A *horizontal construction* is a construction which has its constituents represented in a single sequence of words as in the English sentences 'I want a cookie'. Adult grammar is typically a series of horizontal constructions. Scollon argues that children acquire structures as horizontal constructions only after they first appear as vertical constructions. A *vertical construction* is a construction which has its constituents appearing in a

Table A2.4 : Texts used in verbal protocols experiment - continued

sequence of utterances. Holistic sequences of single-word utterances would be called a vertical construction by Scollon's definition.

An important feature of Scollon's claim is that it is not just restricted to the discussion of the transition from single-word to two-word utterances. Using data from his subject Brenda, he gives cases where three-word horizontal constructions arise from earlier vertical constructions consisting of a sequence of a single-word utterances and a two-word utterance. For example, the semantic structure Agent + Action + Object of the utterance 'baby eat cookie' may occur at an earlier time as 'baby' 'eat cookie'.

The rich interpretation of single-word utterances has been a controversial issue since its first inception. A major feature of this interpretation is that it is consistent with a constructionist view of acquisition where development of linguistic knowledge is seen as beginning in comprehension. In this case, the primitive semantic relational knowledge emerging in comprehension first appears as underlying single-word utterances, then successive single-word utterances, and eventually multiword utterances. Further, it proposes that new grammatical forms, such as successive single-word utterances, are used with already acquired (or 'old') meanings. The idea that new forms mark old meanings and that old forms mark new meanings is a basic Piagetian notion that has been applied to child language by Slobin (1973).

The rich interpretation is in opposition to what can be called the *lean* interpretation of successive single-word utterances. This position has been expressed in Brown (1973), Bloom (1973), Dore (1975) and Barrett (1982) among others.

Year 3 familiar english literature text. From Benson, L.D. (1989) *The Riverside Chaucer*. Oxford University Press, Oxford. (pp 5-6).

The General Prologue was presumably written early in the Canterbury period, though it was not necessarily the first part of the *Tales* to be composed and was probably revised from time to time. Some revisions remained to be made; neither the Second Nun nor the Nun's Priest is described, and it seems likely that Chaucer intended to add their portraits in a later revision. For the General Prologue, as for the Canterbury pilgrimage itself, Chaucer had no exact literary model. The Prologue begins as if it were to be another of his dream visions, cast in the high style evoked by the learned allusions and elaborate syntax of the opening lines. The celebration of the return of spring recalls the opening of *The Romaunt of the Rose*. There the description of spring, with its suggestions of fertility and rebirth, leads to "Than yonge folk entenden ay / Forto ben gay and amorous" (Rom 82-83). Here it leads to another kind of love; "Thanne longen folk to goon on pilgrimages" (ʊ.12). The narrator encounters not a Temple of Venus or a Garden of Love but a real tavern, the Tabard in Southwark, containing not a series of allegorical portraits but what seems a lively assembly of real people, gathered for an actual pilgrimage to Canterbury.

The portraits of Chaucer's pilgrims nevertheless owe a great deal to medieval traditions of literary portraiture, including the series of allegorical descriptions in *The Romaunt of the Rose*. The hypocritical friar, the hunting monk, the thieving miller and others are familiar types in medieval *estates satire*, in which representatives of various classes and occupations are portrayed with a satiric emphasis on the vices peculiar to their stations in life. Each of Chaucer's fully described characters represents a different occupation, and each is a paragon of his or her craft: "wel koude" and "verray parfit" echo throughout the General Prologue, as we are shown that each character well knows how to realize the potentialities of his or her occupation, whether for good or - far more often - for mischief. Much of this satire still strikes the mark, since Chaucer's characters represent more general types as well as their particular occupations.

Nevertheless, each of Chaucer's characters is vividly individualised. The Friar is a representative type of the unctuous hypocrisy one may still encounter in daily life and a clear example of the type of the *hypocritical friar* well known in medieval satire, but he is also a particular individual, with a specific name, Friar Huberd, with his peculiar habits, his lisp, and his own personal history. We even seem to hear the tone of his own voice in his indirectly quoted self-justifications (lines 227-34, 243-48). Likewise, the Knight is an idealized representative of chivalry, but one who has participated in real campaigns, most of them well known to Chaucer's audience, and the Miller is not only the traditional thieving miller, but Robin, with a wart on the end

Table A2.4 : Texts used in verbal protocols experiment - continued

of his nose and the habit of breaking down doors with his head. We glimpse the Prioress weeping when her little dogs are beaten; we are told of the real places from which the pilgrims come; and in such touches as the Wife of Bath's deafness we see the present effects of what seem real past experiences.

Year 3 unfamiliar english literature text. From Patterson, L. (1987) *Negociating the Past: The Historical Understanding of Medieval Literature*. The University Wisconsin Press, London. (p p4-6).

In the 1950s and early 1960s the work of D. W. Robertson first established Exegetics as a major force in the study of medieval literature. Most medievalists hastened to position themselves vis-a-vis this new critical formation. Some issued anathemas (Donaldson, Utley); some offered less global but still severe strictures (Bloomfield, Howard); and some rather gingerly signed up as co-workers in the Exegetical vineyard (Kaske). Without exception, however, these responses remained true to the empirical temper of American criticism. This was achieved by engaging Exegetics at the level of practice, attacking it for historical misrepresentation and interpretive inadequacy or, conversely, seeing in it new possibilities for critical work. Talbot Donaldson candidly acknowledged such an approach was forced on the opposition by its inability to frame a theoretical objection. The result of this pragmatism was that, despite and even because of the devastating force of the practical objections, a confrontation with Exegetics at the level of theory was foreclosed. Moreover, the silent but powerful New Critical reliance upon the educated sensibility as the final arbiter of interpretive common sense ensured that those opposed to Exegetics would continue to decline to articulate a program of medieval literary studies to challenge Exegetics' easily replicated paradigm. This silence was all the more impenetrable because of the necessary implicitness of sensibility itself.

The result has been that Exegetics remains, apparently against all odds, the great unfinished business of Medieval Studies. The point is not simply that the Exegetical method continues to be practiced, but that it continues to arouse passions. Unable to absorb Exegetics and move on, Chaucer studies instead circles back almost compulsively to an apparently irrepressible scandal; a recursiveness that itself bespeaks a scandalous limitation to its own critical creativity. Despite having attained a healthy maturity, Exegetics remains as combative and polemical as ever, while its opponents decline the passé title of New Critics but continue to denigrate a critical approach that is presumably beneath their notice.

Hence criticism has failed to define a strategy of interpretation that would preserve both the indisputable scholarly findings of Exegetics, and the humanist values that Exegetics seeks to annul. Faced with the Exegetical meaning of the Miller's bagpipes, for example, or the Wife of Bath's deafness, critics opposed to Exegetics are largely silent, turning away from these iconographical details in favor of other, less apparently unilateral textual elements. This evasion is especially marked in relation to the medieval tradition of exegetical reading itself, a tradition that Professor Robertson has almost single-handedly brought to the attention of literary scholars but which criticism has sought to quarantine. The task of a fully informed Chaucerian criticism is not, however, to fend off Exegetical findings, but rather to place them within a more inclusive understanding. Exegetical reading is, as everyone would agree, an authentically medieval mode of understanding; and it is one that is inscribed within Chaucerian poetry. Chaucer's poems both invite and, I believe, finally resist exegetical processing. His characteristic poetic strategies are designed not only to evade, but to explore the hegemonic power of institutionalized modes of medieval interpretation. Exegesis, in short, is itself one of Chaucer's subjects, and so vulnerable to his characteristic irony. A fully responsive criticism must accommodate both this interest and the scepticism with which it is regarded.

In this table **exam performance** and **reported LASSI ratings** are compared and contrasted as measures of learning. I have concentrated on the measures that relate to the hypotheses proposed in the verbal protocols experiment discussed in chapter 2. These measures are: (a) comprehension strategy use; (b) comprehension monitoring; (c) the number of strategies to overcome comprehension failure; (d) and the generation of inferences. Analysis of the verbal protocols was undertaken with 1 between subjects effect which was either **exam performance** (learners with high vs. learners with low exam scores) or **reported LASSI ratings** (learners with high reported LASSI ratings vs. learners with low reported LASSI ratings). Two within subjects effects were also included: an effect of **year** compared performances in years 1, 2 and 3; and an effect of **text familiarity** compared performances with familiar and unfamiliar texts.

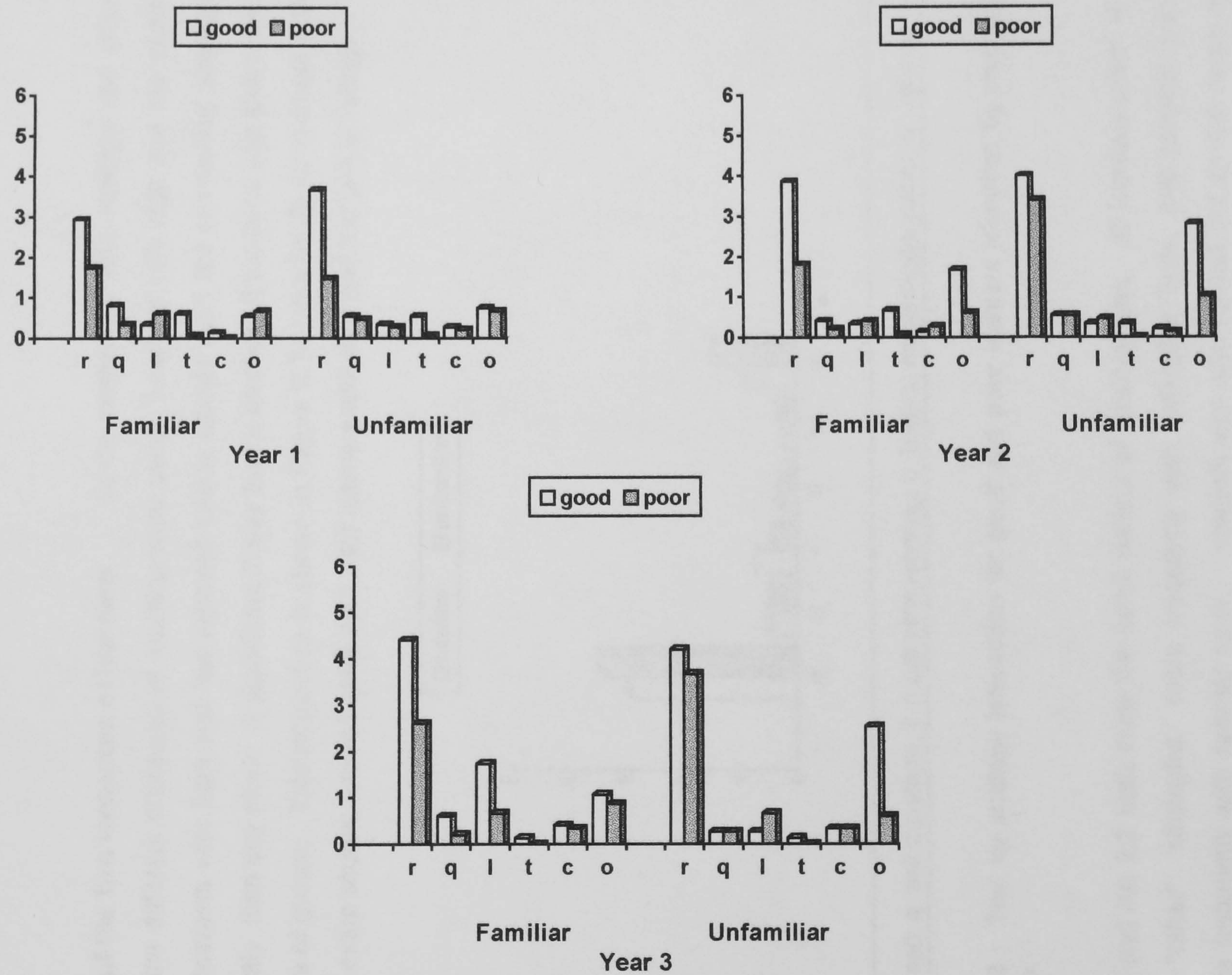
(i) Comprehension strategy use The mean number of strategies used as a function of exam performance was shown in Figure 2.7; while the mean number of strategies used as a function of reported LASSI ratings is shown in Figure AA 2.1 overleaf. The outcomes of analysis on these data are shown in Table AA 2.1. Results with reported LASSI rating are shown on the right hand panel of the table while results with exam performance are shown on the left hand panel. Furthermore, significant results with exam performance but not reported LASSI ratings are marked with one asterisk (*); while significant results with reported LASSI ratings but not exam performance are marked with two asterisks (**).

	measure of learning					
	exam performance			reported LASSI ratings		
source of variation	df	F	p	df	F	p
strategy use						
good vs poor	1,24	5.26	.03	1,28	2.60	ns *
year	2,48	2.55	.09	2,56	2.82	.07
text	1,24	1.28	ns	1,28	1.31	ns
type of strategy	5,120	21.55	.000	5,140	23.89	.000
group x strategy	5,120	3.13	.01	5,140	1.36	ns *
text by strategy	5,120	3.00	.01	5,140	2.79	.02
group x year x text	2,48	4.01	.02	2,56	0.44	ns *
group x year x text x strategy	10,240	2.42	.01	10,280	1.54	ns *

* results are significant for performers but non-significant for learners

Table AA 2.1 : Outcome of analyses of comprehension strategies.

Differences between the two measures of learning Table AA 2.1 shows that an effect of **group** (good vs. poor learners) was found when exam performance was used as a measure of learning but not when reported LASSI ratings was used While learners with high exam scores used more strategies than learners with low exam scores, learners with high LASSI ratings did not use more strategies than learners with low LASSI ratings. A **group x type of strategy** interaction was also found with exam performance but not with reported LASSI ratings. Figure 2.8 (see chapter 2) shows that learners with high exam scores used re-reading and "other" strategies more often than learners with low exam scores - but this was not apparent when



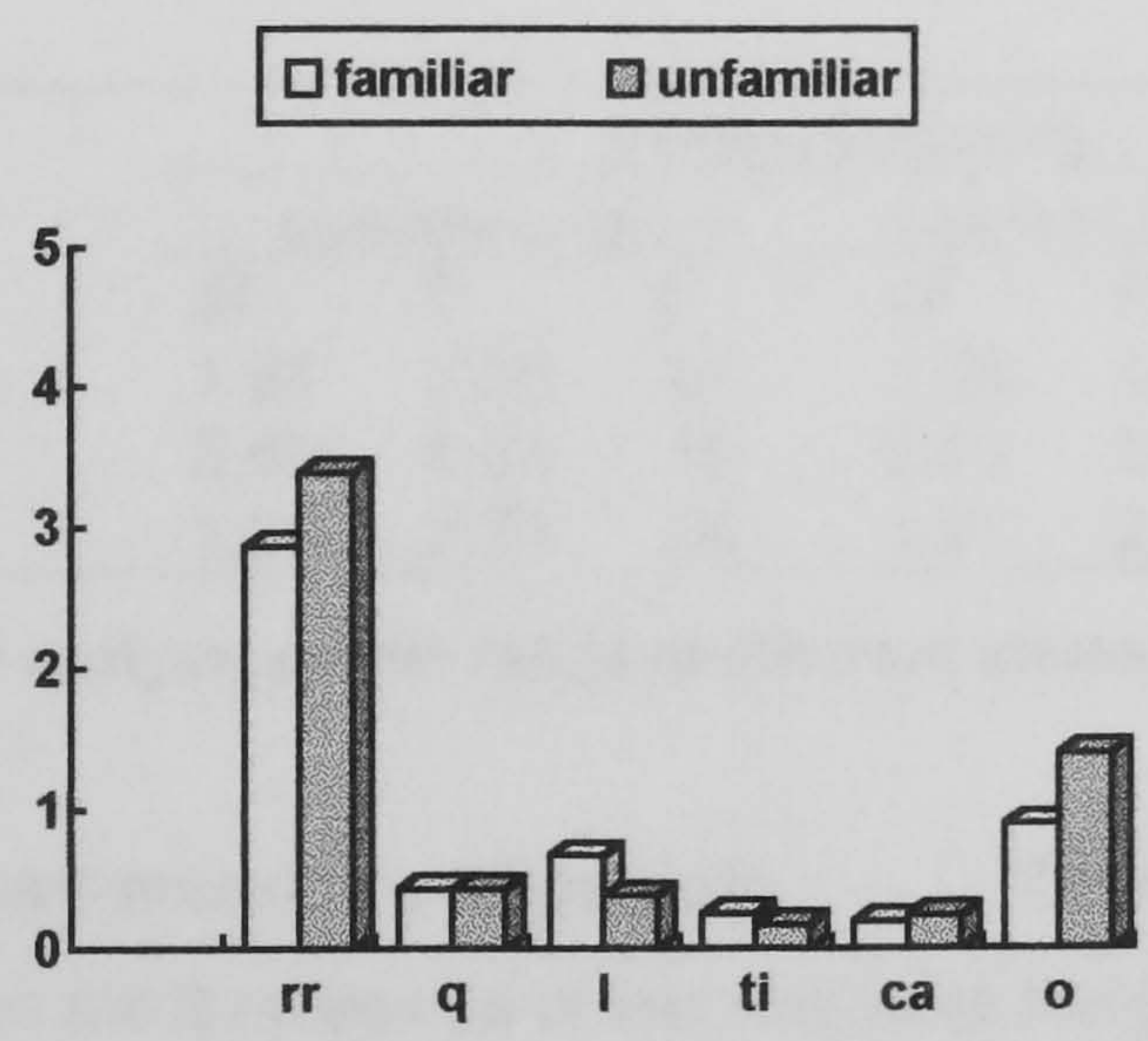
Code: **r** re-read; **q** question; **l** recall prior learning; **t** take the text in; **c** challenge the author; **o** other

Figure AA2.1 Comprehension strategies used by good and poor learners (identified by reported LASSI ratings).

Table A2.5 : Analysis with reported ratings as the measure of learning ability.

reported LASSI ratings was used as a measure of learning. Furthermore, a 3-way **year x text x type of strategy** interaction was found with learners with high exam scores but not with learners with low exam scores. Figure 2.11 (see chapter 2) shows that learners with high exam scores used the re-reading strategy more frequently with unfamiliar texts in year 2, but with familiar texts in years 1 and 3; learners with high exam scores also recalled prior learning more frequently when reading familiar texts in the third year. None of these interactions were found with good and poor learners when reported LASSI ratings were used as a measure of learning.

Similarities of the two measures of learning Some similarities with strategy use were found when the different measures of learning were used. Learners with high and low exam scores, and learners with high and low reported LASSI ratings used the **re-reading** strategy more frequently than any other. A significant 2-way **text x strategy** interaction was also found with both sets of groups. This interaction is shown in Figure 2.10 (chapter 2) for learners with high and low exam scores; and in Figure AA2.2 for learners with high and low LASSI ratings.



Code: **rr** re-read; **q** ask questions; **l** recall prior learning; **ti** take-in; **ca** challenge author; **o** others.

Figure AA 2.2 : Text by strategy interaction for good and poor learners identified by reported LASSI ratings.

Figures 2.10 and AA 2.2 both show the same pattern of strategy use; all learners used re-reading and "other" strategies more frequently with unfamiliar texts, and recalled prior learning more frequently with familiar texts. Analysis was also carried out on the range of different strategies used when reading. The data for learners identified by exam performance is shown in Figure 2.14 while the data for learners identified by reported LASSI ratings is shown in Figure AA 2.3. The outcomes of analysis on both sets of data is shown in Table AA 2.2.

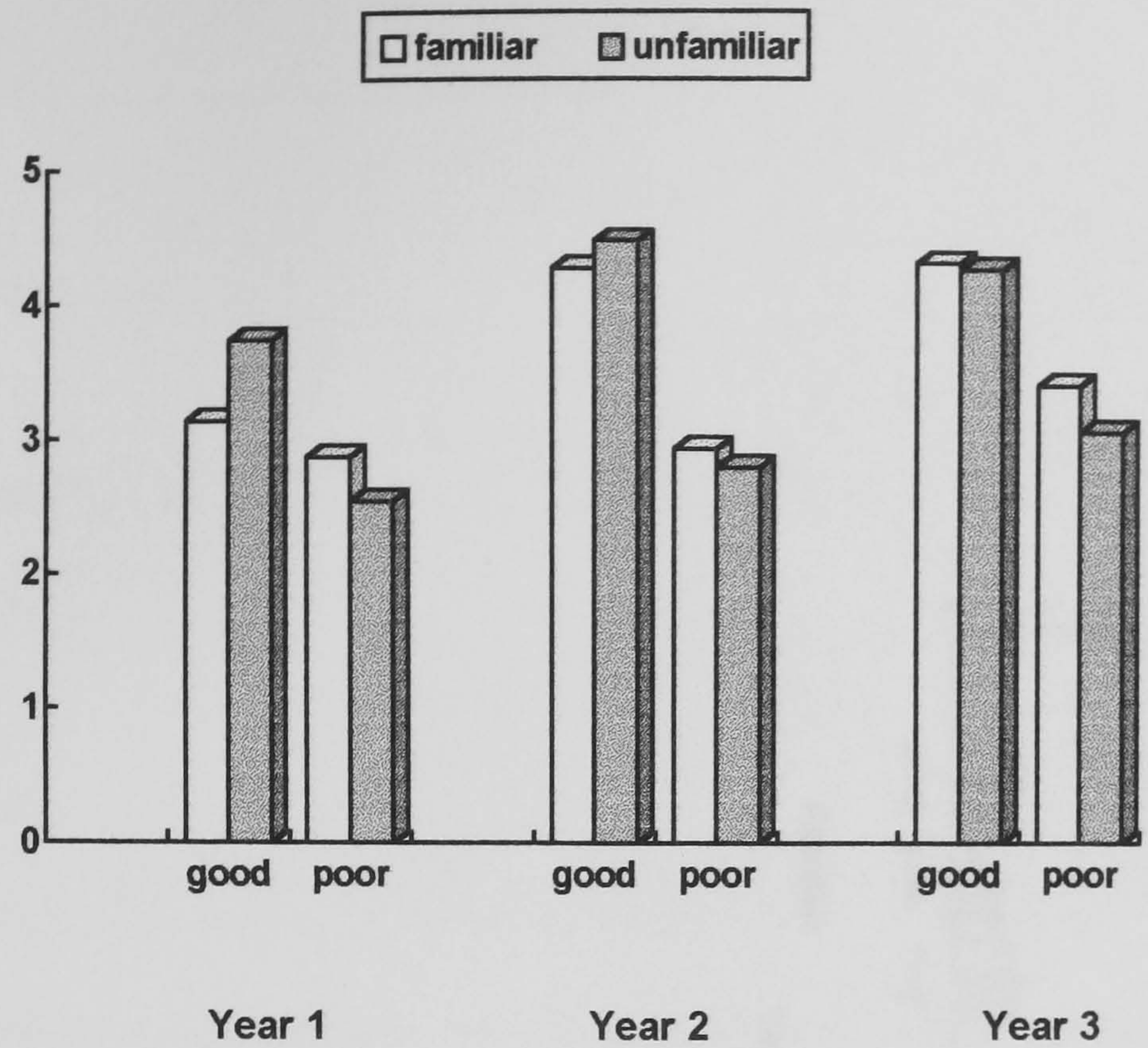


Figure AA 2.3 Number of different strategies used by good and poor learners identified by reported LASSI ratings.

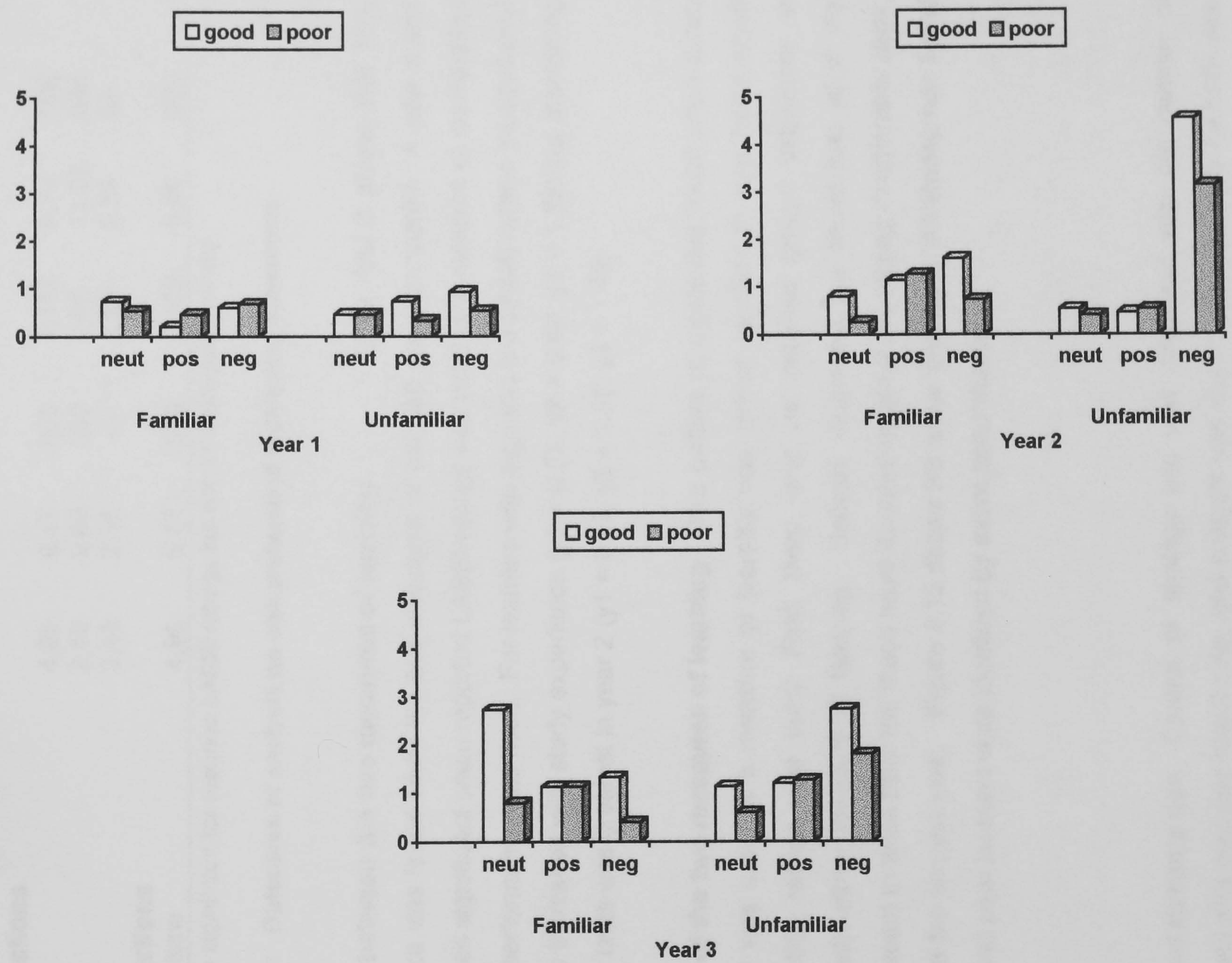
	measure of learning					
	exam performance			reported LASSI ratings		
source of variation	**df**	**F**	**p**	**df**	**F**	**p**
good vs poor	1,24	7.89	.01	1,28	4.14	.05
year	2,48	4.27	.02	2,56	3.94	.03
group x text	1,24	3.70	.06	1,28	2.10	.16

Table AA 2.2 : Outcomes of analysis on the range of different strategies used.

Differences between the two measures of learning Table AA2.2 shows that no differences were found when the 2 measures of learning were compared.

Similarities of the two measures of learning A main effect of **group** was found with both sets of groups; learners with high exam scores (4.1) used a greater number of strategies than learners with low exam scores (2.7) and the same trend was found with learners with high (4.0) and low (2.9) LASSI ratings. Furthermore, a main effect of **year** was also found with both sets of groups; learners with high and low exam scores (y1 = 3, y2 = 3.4, Y3 = 3.8) and learners with high and low LASSI ratings (y1 = 3, y2 = 3.6, y3 = 3.7) all used a greater number of different strategies as they gained more study experience.

(ii) Comprehension Monitoring The comprehension monitoring of groups determined by reported LASSI ratings is shown in Figure AA 2.4 while the comprehension monitoring of groups determined by exam performance was shown in Figure 2.15 in chapter 2. Outcomes of analysis with both measures of learning is shown in Table AA 2.3.



Code: neut neutral; **pos** positive; **neg** negative

Figure AA2.4 Comprehension monitoring of good and poor learners identified by reported LASSI ratings

Table A2.5 : Analysis with reported ratings as the measure of learning ability.

	measure of learning					
	exam performance			reported LASSI ratings		
source of variation	df	F	p	df	F	p
comprehension monitoring						
good vs. poor	1,24	0.15	ns	1,28	2.33	ns
year	2,48	7.46	.002	2,56	9.30	.000
text	1,24	5.36	.03	1,28	4.18	.05
type: (neutral vs positive vs negative)	2,48	9.42	.000	2,56	7.18	.002
2-way interactions						
year x type	4,96	8.47	.000	4,112	8.79	.000
text x type	2,48	9.80	.000	2,56	11.32	.000
year x text	2,48	2.16	ns * *	2,56	2.98	.05
3-way interactions						
year x text x type	4,96	6.37	.000	4,112	8.40	.000

** results were significant for reported LASSI ratings but not for exam performance

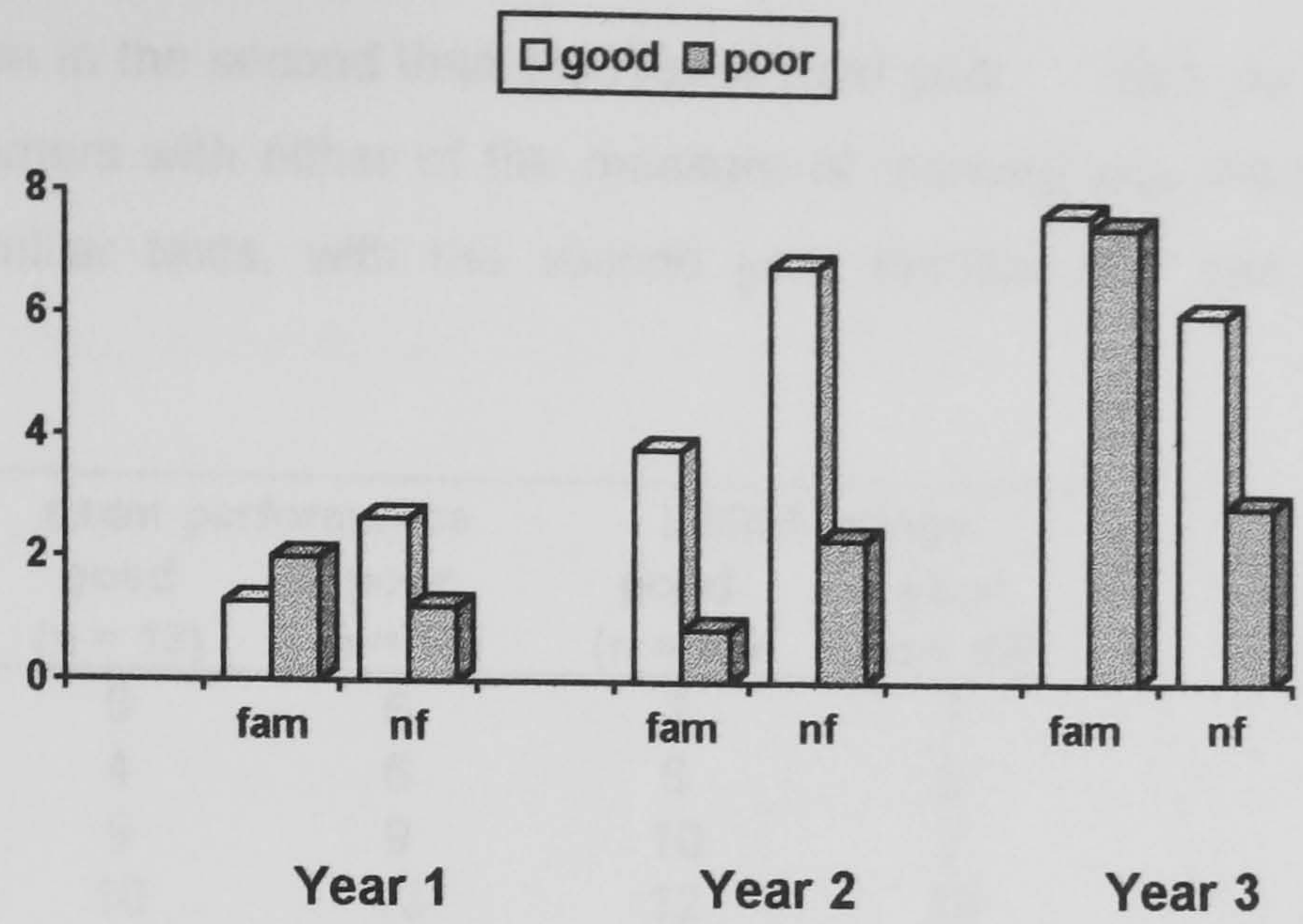
Table AA 2.3 : Outcomes of analysis on comprehension monitoring statements.

Differences between the two measures of learning Table AA2.3 shows that only one difference was found when the two measures of learning were compared. A year x text interaction was significant when reported LASSI ratings was used as a measure of learning but when exam performance was used. For learners with high and low LASSI ratings monitoring of familiar texts increased with study experience (y1 = 0.53, y2 = 0.92, y3 = 1.25) but monitoring of unfamiliar texts was greatest in year 2 (y1 = 0.57, y2 = 1.59, y3 = 1.45).

Similarities of the two measures of learning The pattern of monitoring found when exam performance was used as a measure of learning was almost identical to that found when reported LASSI ratings was used. First, there were *no between groups differences* in monitoring with either measure of learning. Second, Figure AA 2.4 shows that all of the interactions seem to arise from the much *more frequent negative monitoring of unfamiliar texts*, particularly in the second year. Figure 2.15 shows the same pattern of monitoring was found when good and poor learners were identified by exam performance.

(iii) Control of strategy use Control of strategy use was measured with the number of strategies used with negative monitoring, and analysis was carried out separately for each year of study, and for each type of text (familiar or unfamiliar). This data is shown in Figure AA 2.5 (with reported LASSI ratings) and Figure 2.20 (with exam performance). The outcomes of analysis on this data is shown in Table AA 2.4.

Table A2.5 : Analysis with reported ratings as the measure of learning ability.



Code: fam familiar texts; **nf** unfamiliar texts

Figure AA2.5 Mean number of strategies used with negative monitoring.

	measure of learning					
	exam performance			reported LASSI ratings		
source of variation	**df**	**F**	**p**	**df**	**F**	**p**
Year 1 familiar texts						
group	1, 10	2.39	ns	1, 12	0.29	ns
year 1 unfamiliar texts						
group	1, 8	3.58	.09	1, 9	0.94	ns
year 2 familiar texts						
group	1, 16	1.91	ns	1, 15	2.81	ns
year 2 unfamiliar texts						
group	1, 21	4.87	.04	1, 24	3.03	.09 *
year 3 familiar texts						
group	1, 5	8.11	.04	1, 9	0.00	ns *
year 3 unfamiliar texts						
group	1, 19	2.52	ns	1, 22	1.52	ns

* results were significant with exam performance but not with reported LASSI ratings

Table AA 2.4 : Outcomes of analysis on the strategies used with negative monitoring.

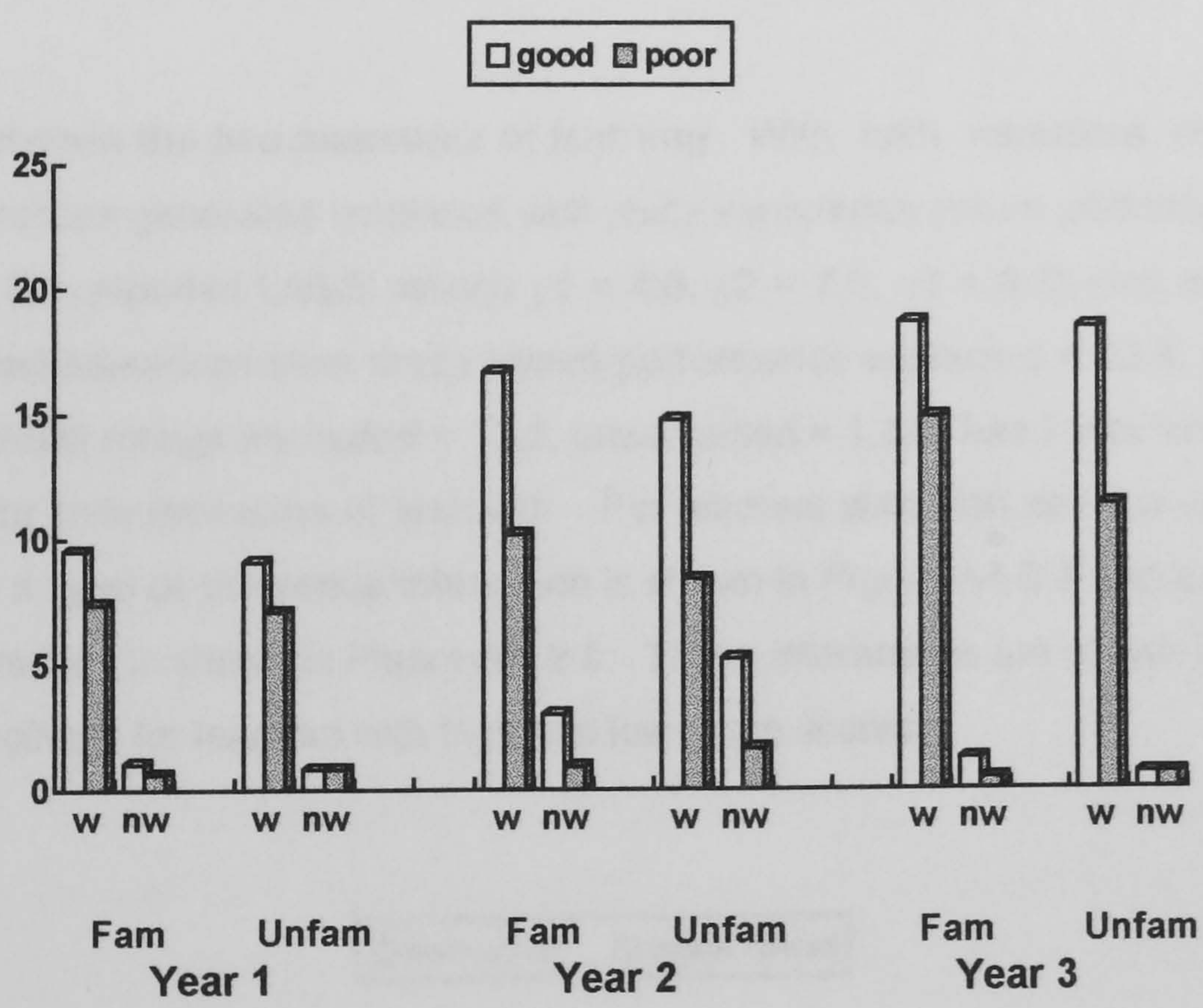
Differences between the 2 measures of learning In contrast to exam performance, no difference between the two groups was found with reported LASSI ratings in any of the conditions. With exam performance learners with high exam scores used more strategies when negatively monitoring their understanding of the second year unfamiliar text; the third year familiar text; and marginally more with the first year unfamiliar text. No similar findings were apparent with good and poor learners identified by reported measures of learning.

Similarities between the 2 measures of learning The number of students who negatively monitored the text while reading is shown in Table AA 2.5. Table AA 2.5 shows that the number of students who monitored their understanding of *unfamiliar* texts increased as the students became more experienced. By their final year, most students monitored their comprehension when reading unfamiliar texts. With familiar texts, more students monitored their comprehension in the second than the first or third year. Also, no differences between good and poor learners with either of the measure of learning was found with the first year familiar and unfamiliar texts, with the second year familiar text and with the third year unfamiliar text.

	exam performance		LASSI ratings	
	good (n = 13)	poor (n = 13)	good (n = 15)	poor (n = 15)
Y1 familiar	6	6	7	7
y1 unfamiliar	4	6	6	5
y2 familiar	9	9	10	7
y2 unfamiliar	10	13	12	14
y3 familiar	4	3	7	4
y3 unfamiliar	8	13	13	12

Table AA 2.5 Number of students who negatively monitored their understanding while reading.

(vi) Inferences The mean number of inferences generated by learners with high and low exam scores and learners with high and low LASSI ratings are shown in Figures 2.21 and AA 2.6 respectively. The outcomes of analysis on these data are shown in Table AA 2.6.



Code: fam familiar texts; **unfam** unfamiliar texts; **w** warranted inferences; **nw** unwarranted inferences

Figure AA 2.6 : Warranted and unwarranted inferences for good and poor learners identified by reported LASSI ratings.

Differences between the two measures of learning Inspection of Table AA2.6 shows that the main effect of group found with exam performance was not significant with reported LASSI ratings. Learners with high exam scores (mean = 10) made more inferences than learners with low exam scores (mean = 4) but no similar superiority was found with learners with high

LASSI ratings. Furthermore, no interactions were found with reported LASSI ratings. Interactions with exam performance arose because: learners with low exam scores made more unwarranted inferences with the second year familiar and unfamiliar texts while learners with high exam scores made more warranted and unwarranted inferences with all other texts (see Figure 2.25); and warranted inferences increased with study experience while unwarranted inferences were greatest with the familiar and unfamiliar second year texts (see Figure 2.26)

	measure of learning					
	exam performance			reported LASSI ratings		
source of variation	df	F	p	df	F	p
inferences						
good vs poor	1,24	6.64	.02	1,28	1.81	ns *
year	2,48	8.09	.001	2,56	11.35	.000
type	1,24	35.57	.000	1,28	31.90	.000
group x type	1,24	9.48	.005	1,28	0.83	ns *
year x type	2,48	9.38	.000	2,56	12.75	.000
text x type	1,24	5.41	.029	1,28	5.30	.029
group x year x type	2,48	3.29	.046	2,56	0.52	ns *
year x text x type	2,48	3.12	.05	2,56	1.73	ns *

* results were significant for performers but non significant for learners

Table AA 2.6 : Outcomes of analyses on inferences for good and poor learners.

Similarities between the two measures of learning With both measures of learning the number of inferences generated increased with study experience (exam performance y1 = 5.1, y2 = 8.0, y3 = 8.4; reported LASSI ratings y1 = 4.6, y2 = 7.6, y3 = 8.3); and more warranted than unwarranted inferences were made (exam performance warranted = 12.8, unwarranted = 1.6; reported LASSI ratings warranted = 12.3, unwarranted = 1.4). Two 2-way interactions were also identical for both measures of learning. For learners with high and low reported LASSI ratings a **year x type of inference** interaction is shown in Figure AA 2.7 and a **text x type of inference** interaction is shown in Figure AA 2.8. These interactions are shown in Figures 2.23 and 2.24 respectively for learners with high and low exam scores.

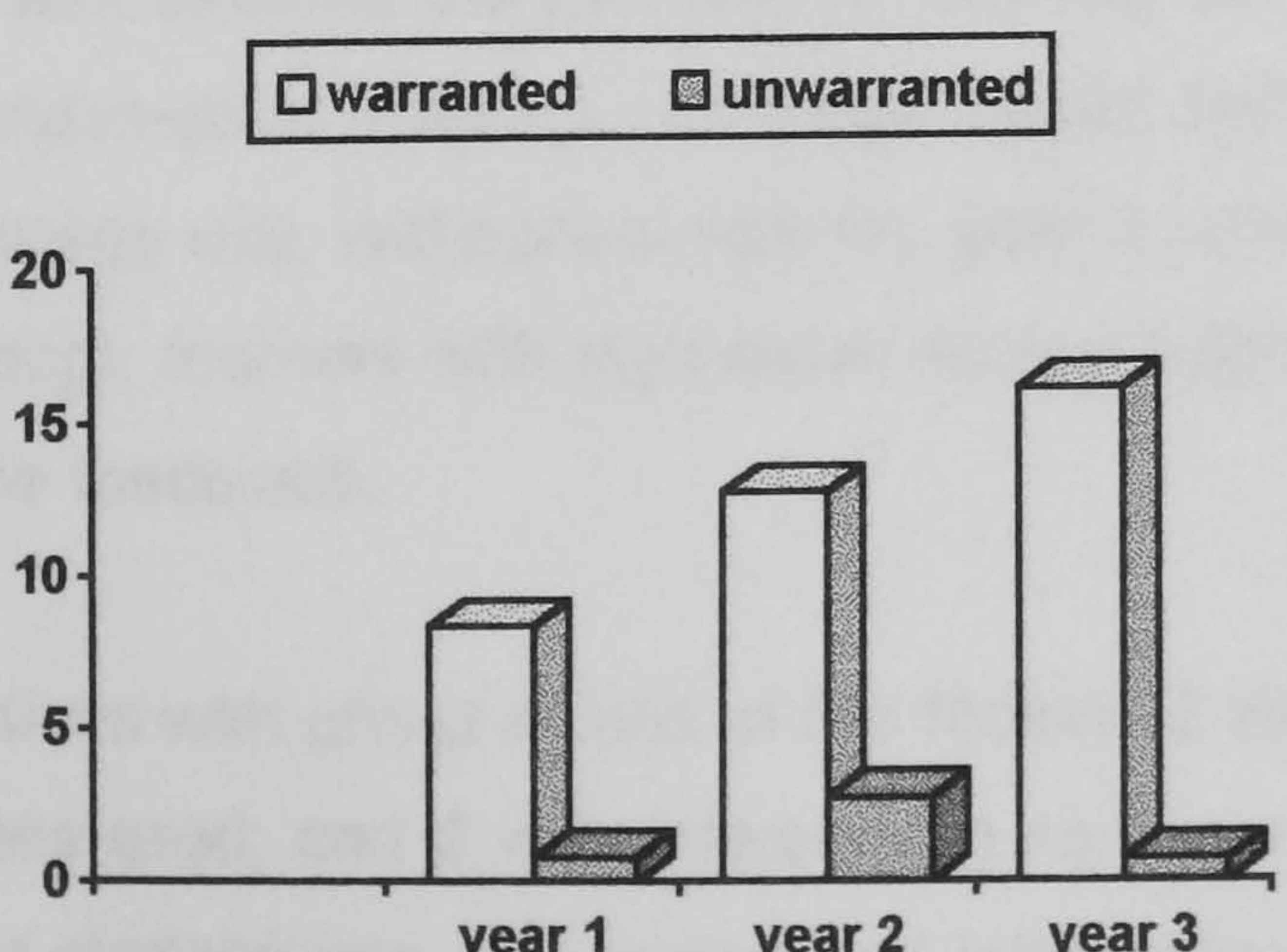


Figure AA 2.7 Year x type of inference interaction for good and poor learners (identified by reported LASSI ratings)

Table A2.5 : Analysis with reported ratings as the measure of learning ability.

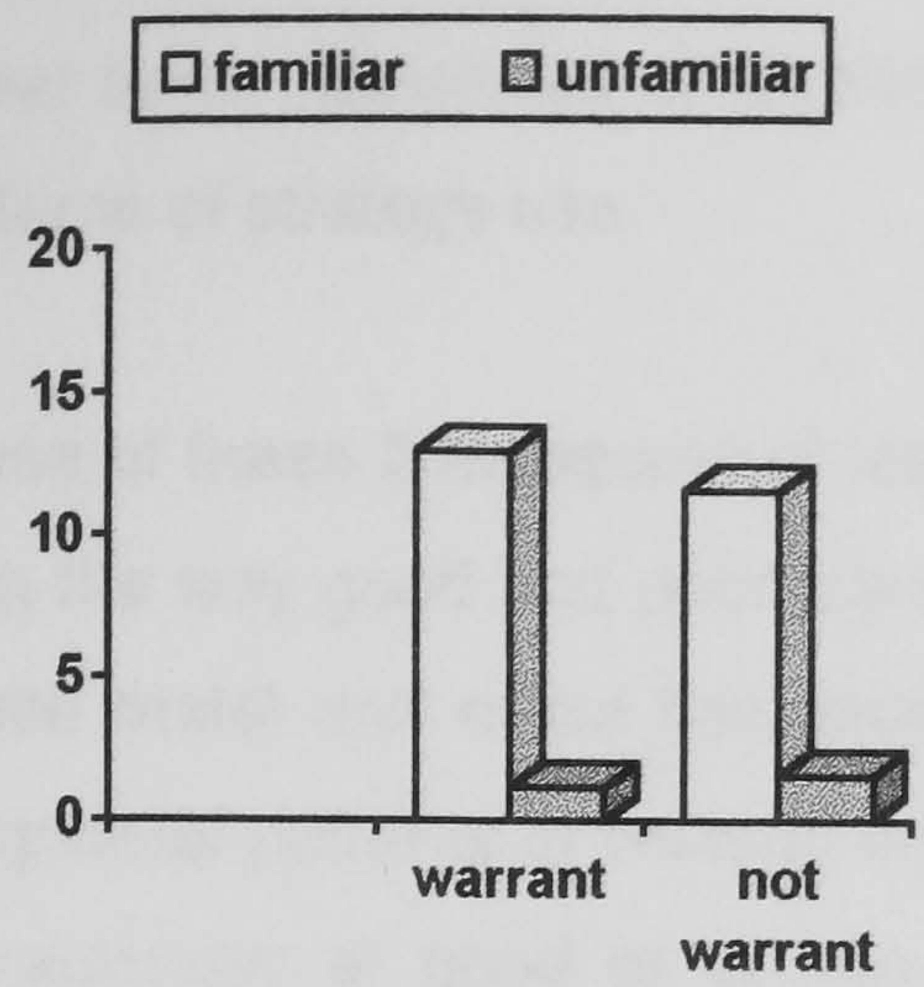


Figure AA 2.8 Text x type of inference for good and poor learners (identified by reported LASSI ratings)

Figure AA 2.7 shows the year x type of interaction arises because warranted inferences increase with study experience while unwarranted inferences are greatest in year 2. Figure AA 2.8 shows the text x type of inference interaction arises because warranted inferences were greater with familiar texts while unwarranted inferences were slightly increased with unfamiliar texts. The same trends can be seen in Figures 2.23 and 2.24 when exam performance is used as the measure of learning.

Overall differences and similarities between the two measures of learning The most striking finding from comparisons of analyses based on *exam performance* with analysis based on *reported LASSI ratings* is that exam performance was more able to detect between groups differences than reported LASSI ratings. Significant differences between learners with high and low exam scores were detected far more often than significant differences between learners with high and low reported LASSI ratings.

Tables AA 2.1 - AA 2.4 and Table AA 2.6 show that 13 effects and interactions were significant when exam performance was used as the measure of learning but not when reported LASSI ratings was used as the measure of learning. Of these effects and interactions there were 4 main effects of group (strategy use, self-control with the year 2 unfamiliar text and the year 3 familiar text, and inferencing); learners with high exam scores outperformed learners with low exam scores on all of these measures.

There were also 6 interactions with group as one of the factors (3 with strategy use, 1 with the range of different strategies used; and 2 with inferencing) so exam performance was able to detect different patterns of strategy use, self-control and inferencing. Learners with high exam scores compared to learners with low exam scores: used the re-reading strategy more often with the second year unfamiliar text and recalled prior learning more frequently with the third year familiar text; used a greater number of different strategies with unfamiliar rather than familiar texts; and made more warranted inferences with all texts but more unwarranted inferences with first and third-year texts. Measures of learning from the LASSI ratings did not detect any of these different patterns of strategy use.

The main conclusion from the use of these 2 measures of learning is that **exam performance** appears to capture differences in the way good and poor learners use strategies, regulate their understanding (at least with some texts) and make inferences. In contrast, **reported LASSI ratings** appear to capture only general patterns of reading behaviour that are characteristic of most students rather than characteristic of good or of poor students. One example of a reading pattern characteristic of many students was found with comprehension monitoring. All students in this study: monitored their understanding more frequently as they gained more study experience; monitored text more often with unfamiliar than familiar texts; and had more negative than positive or neutral monitoring. This pattern of monitoring was found when either exam performance or reported LASSI ratings was used as the measure of learning, and is probably characteristic of the way that most university students monitor their comprehension of expository text. However, exam performance was no better than reported learning ability at detecting between groups differences in monitoring. The general pattern of much more frequent negative monitoring with unfamiliar texts - particularly in the second and third years - was detected with both good and poor performers and good and poor learners. Taken together the findings suggest that comprehension monitoring is a skill which develops throughout the years of study, is most often used when reading unfamiliar material. However, a more sensitive measure than exam performance or reported learning ability is needed to detect differences between good and poor students. Alternatively, comprehension monitoring may be not be linked to learning ability. This view has been recently proposed by Pressley & Ghatala (1990) " ... *adequate monitoring can be observed across a range of abilities, as can inadequate monitoring.*"

Table A2.6 Analysis of variance of **mean reading times** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	4270102.18	24	177920.92		
group	650547.92	1	650547.92	3.66	.068
Within subjects + residual	748325.67	48	15590.12		
year	109602.09	2	54801.04	3.52	.038
group x year	16574.58	2	8287.29	.53	ns
Within subjects + residual	155717.36	24	6488.22		
text familiarity (text)	34800.64	1	34800.64	5.36	.029
group x text	156.00	1	156.00	.02	ns
Within subjects + residual	446782.18	48	9307.96		
year x text	62522.01	2	31261.01	3.36	.043
group x year x text	36230.81	2	18115.4	1.95	ns

Table A2.7 Analysis of variance of **mean number of utterances** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	345.30.00	24	1438.75		
group	11051.08	1	11051.08	7.68	.011
Within subjects + residual	9920.46	48	206.68		
year	3677.65	2	1838.83	8.90	.001
group x year	250.55	2	125.28	.61	ns
Within subjects + residual	1315.69	24	54.82		
text familiarity (text)	44.16	1	44.16	.81	ns
group x text	.31	1	.31	.01	ns
Within subjects + residual	2194.46	48	45.72		
year x text	45.86	2	22.93	.50	ns
group x year x text	55.01	2	27.51	.60	ns

Table A2.8 Analysis of variance of **mean number of comprehension strategies** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of strategy** (strategy). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	393.55	24	16.40		
group	86.17	1	86.17	5.26	.031
Within subjects + residual	232.80	48	4.85		
year	24.76	2	12.38	2.55	.088
group x year	2.05	2	1.03	.21	ns
Within subjects + residual	54.09	24	2.25		
text familiarity (text)	2.89	1	2.89	1.28	ns
group x text	2.46	1	2.26	1.09	ns
Within subjects + residual	1114.56	120	9.29		
strategy	1000.65	5	200.13	21.55	.000
group x strategy	145.57	5	29.11	3.13	.011
Within subjects + residual	104.00	48	2.17		
year x text	8.36	2	4.18	1.93	ns
group x year x text	17.37	2	8.68	4.01	.025
Within subjects + residual	959.25	240	4		
year x strategy	45.31	10	4.53	1.13	ns
group x year x strategy	12.16	10	1.22	.30	ns
Within subjects + residual	210.78	120	1.76		
text x strategy	26.37	5	5.27	3.00	.014
group x text x strategy	5.41	5	1.08	.62	ns
Within subjects + residual	331.44	240	1.38		
year x text x strategy	16.42	10	1.64	1.19	ns
group x year x text x strategy	33.42	10	3.34	2.42	.009

Table A2.9 Analysis of variance of the **infrequently used strategy of identifying unfamiliar terms** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	24.00	24	1		
group	.01	1	.01	.01	ns
Within subjects + residual	36.92	48	.77		
year	2.81	2	1.40	1.83	ns
group x year	.94	2	.47	.61	ns
Within subjects + residual	11.38	24	.47		
text familiarity (text)	.78	1	.78	1.64	ns
group x text	.01	1	.01	.01	ns
Within subjects + residual	20.00	48	.42		
year x text	2.86	2	1.43	3.43	.04
group x year x text	.47	2	.24	.57	ns

Table A2.10 Analysis of variance of the **infrequently used strategy of defining unfamiliar terms** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	1.00	24	.04		
group	.01	1	.01	.15	ns
Within subjects + residual	1.23	48	.03		
year	.05	2	.03	1	ns
group x year	.05	22	.03	1	ns
Within subjects + residual	.38	24	.02		
text familiarity (text)	.06	1	.06	3.60	.070
group x text	.06	1	.06	3.60	.070
Within subjects + residual	1.85	48	.04		
year x text	.00	2	.00	.00	ns
group x year x text	.15	2	.08	2	ns

Table A2.11 Analysis of variance of the **infrequently used strategy of link text segments** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	14.74	24	.61		
group	1.08	1	1.08	1.76	ns
Within subjects + residual	12.56	48	.26		
year	2.09	2	1.04	3.99	.025
group x year	1.01	22	.51	1.93	ns
Within subjects + residual	7.67	24	.32		
text familiarity (text)	.06	1	.06	.18	ns
group x text	.78	1	.78	2.43	ns
Within subjects + residual	8.10	48	.17	.80	.456
year x text	.27	2	.13	.80	ns
group x year x text	.63	2	.31	1.86	ns

Table A2.12 Analysis of variance of the **infrequently used strategy of reading ahead** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	31.36	24	1.31		
group	4.33	1	4.33	3.32	.081
Within subjects + residual	25.72	48	.54		
year	1.04	2	.52	.97	ns
group x year	.24	2	.12	.23	ns
Within subjects + residual	11.36	24	.47		
text familiarity (text)	.41	1	.41	.87	ns
group x text	.23	1	.23	.49	ns
Within subjects + residual	20.18	48	.42		
year x text	.55	2	.28	.66	ns
group x year x text	.27	2	.13	.32	.728

Table A2.13 Analysis of variance of the **infrequently used strategy of recalling real life experiences** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	22.92	24	.96		
group	1.64	1	1.64	1.72	ns
Within subjects + residual	19.46	48	.41		
year	.04	2	.02	.05	ns
group x year	.17	2	.08	.21	ns
Within subjects + residual	16.51	24	.69		
text familiarity (text)	2.56	1	2.56	3.73	.065
group x text	1.26	1	1.26	1.83	ns
Within subjects + residual	15.41	48	.32		
year x text	.17	2	.08	.26	ns
group x year x text	.09	2	.04	.14	ns

Table A2.14 Analysis of variance of the **infrequently used strategy of identifying important points** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	1.49	24	.06		
group	.10	1	.10	1.66	ns
Within subjects + residual	1.90	48	.04		
year	.05	2	.03	.65	ns
group x year	.05	2	.03	.65	ns
Within subjects + residual	1.23	24	.05		
text familiarity (text)	.10	1	.10	2.00	ns
group x text	.00	1	.00	.00	ns
Within subjects + residual	2.46	48	.05		
year x text	.05	2	.03	.50	ns
group x year x text	.15	2	.08	1.50	ns

Table A2.15 Analysis of variance of **mean number of different strategies used** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	235.79	24	9.82		
group	77.56	1	77.56	7.89	.010
Within subjects + residual	104.67	48	2.18		
year	18.63	2	9.31	4.27	.020
group x year	8.71	2	4.35	2.00	ns
Within subjects + residual	32.62	24	1.36		
text familiarity (text)	.03	1	.03	.02	ns
group x text	5.03	1	5.03	3.70	.066
Within subjects + residual	85.9	48	1.79		
year x text	1.63	2	.81	.46	ns
group x year x text	6.01	2	3.01	1.68	ns

Table A2.16 Analysis of variance of **mean number of comprehension monitoring strategies** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **positive vs. negative vs. neutral monitoring** (pos\neg\neut). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	283.75	24	11.82		
group	1.80	1	1.80	.15	ns
Within subjects + residual	165.09	48	3.44		
year	51.32	2	12.83	25.66	.002
group x year	3.36	2	1.68	.49	ns
Within subjects + residual	65.89	24	2.75		
text familiarity (text)	14.72	1	14.72	5.36	.029
group x text	1.56	1	1.56	.57	ns
Within subjects + residual	240.27	48	5.01		
positive vs negative vs neutral (pos\neg\neut)	94.32	2	47.16	9.42	.000
group x pos\neg\neut	2.18	2	1.09	.22	ns
Within subjects + residual	62.85	48	1.31		
year x text	5.65	2	2.82	2.16	ns
group x year x text	2.17	2	1.08	.83	ns
Within subjects + residual	194.19	96	2.02		
year x pos\neg\neut	68.55	4	17.14	8.47	.000
group x year x pos\neg\neut	2.48	4	.62	.31	ns
Within subjects + residual	193.98	48	4.04		
text x pos\neg\neut	79.18	2	39.59	9.80	.000
group x text x pos\neg\neut	6.50	2	3.25	.80	ns
Within subjects + residual	162.43	96	1.69		
year x text x pos\neg\neut	43.12	4	10.78	6.37	.000
group x year x text x pos\neg\neut	11.45	4	2.86	1.69	ns

Table A2.17 Analysis of variance of **mean number of comprehension episodes** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	4218.67	24	175.78		
group	1280.83	1	1280.83	7.29	.013
Within subjects + residual	918.26	48	19.13		
year	93.81	2	46.90	2.45	.097
group x year	57.27	2	28.63	1.50	ns
Within subjects + residual	159.03	24	6.63		
text familiarity (text)	22.31	1	22.31	3.37	.079
group x text	.16	1	.16	.02	ns
Within subjects + residual	174.67	48	3.64		
year x text	12.94	2	6.47	1078	ns
group x year x text	4.40	2	2.20	.60	ns

Table A2.18 Analysis of variance of **mean number of comprehension episodes with negative monitoring** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	378.33	24	15.76		
group	2.56	1	2.56	.16	ns
Within subjects + residual	220.28	48	4.59		
year	90.63	2	45.31	9.87	.000
group x year	.09	2	.04	.01	ns
Within subjects + residual	211.10	24	8.80		
text familiarity (text)	89.26	1	89.26	10.15	.004
group x text	.64	1	.64	.07	ns
Within subjects + residual	129.97	48	2.71		
year x text	38.47	2	19.24	7.10	.002
group x year x text	6.55	2	3.28	1.21	ns

Table A2.19 Analysis of variance of **mean number of strategies used in comprehension episodes with negative monitoring** with between subjects factor of **group** (good vs. poor learners identified by exam performance). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Year 1 familiar text					
between groups	14.08	1	14.08	2.39	ns
within groups	58.83	10	5.88		
Year 1 unfamiliar text					
between groups	20.42	1	20.41	3.58	.09
within groups	45.58	8	5.69		
Year 2 familiar text					
between groups	26.88	1	26.88	1.91	ns
within groups	225.11	16	14.06		
Year 2 unfamiliar text					
between groups	192.66	1	192.66	4.86	.03
within groups	831.33	21	39.58		
Year 3 familiar text					
between groups	174.29	1	174.29	8.11	.03
within groups	107.41	5	21.48		
Year 3 unfamiliar text					
between groups	88.64	1	88.64	2.47	ns
within groups	680.30	19	35.80		

Table A2.20 Analysis of variance of **mean number of inferences** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of inference** (warranted vs. unwarranted). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	9998.60	24	416.61		
group	2766.16	1	2766.16	6.64	.017
Within subjects + residual	1954.86	48	40.73		
year	659.26	2	329.63	8.09	.001
group x year	157.72	2	78.86	1.94	ns
Within subjects + residual	304.76	24	12.70		
text familiarity (text)	19.00	1	19.00	1.50	ns
group x text	16.16	1	16.16	1.27	ns
Within subjects + residual	6615.27	24	275.64		
type of inference	9804.49	1	9804.49	35.57	.000
group x type of inference	2613.49	1	2613.49	9.48	.005
Within subjects + residual	494.47	48	10.30		
year x text	12.03	2	6.01	.58	ns
group x year x text	24.33	2	12017	1.18	ns
Within subjects + residual	1641.04	48	34.19		
year x type of inference	641.02	2	320.18	9.38	.000
group x year x type of inference	224.85	2	112.42	3.29	.046
Within subjects + residual	396.65	24	16.53		
text x type of inference	89.39	1	83.38	5.41	.029
group x text x type of inference	43.87	1	43.87	2.65	ns
Within subjects + residual	662.65	48	13.81		
year x text x type of inference	86.18	2	43.09	3.12	.053
group x year x text x type of inference	39.00	2	19.50	1.41	ns

Table A2.21 Analysis of variance of **mean comprehension ratings** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	33.86	21	1.61		
group	4.46	1	4.46	2.77	ns
Within subjects + residual	29.92	42	.71		
year	10.08	2	5.04	7.08	.002
group x year	.17	2	.08	.12	ns
Within subjects + residual	12.64	21	.60		
text familiarity (text)	18.85	1	18.85	31.32	.000
group x text	.76	1	.76	1.27	ns
Within subjects + residual	22.74	42	.54		
year x text	11.48	2	5.74	10.60	.000
group x year x text	3.74	2	1.87	3.45	.041

Table A2.22 **Effects of text version on comprehension monitoring in year 1.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); main effect of **general vs specific monitoring** (gen\spec); and main effect of **positive vs. negative vs. neutral monitoring** (pos\neg\neut). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	14.75	22	.67		
text version (version)	2.26	1	2.26	3.37	.080
group	1.23	1	1.23	1.84	ns
version x group	.00	1	.00	.00	ns
Within subjects + residual	9.36	22	.43		
text familiarity (text)	.12	1	.12	.27	ns
version x text	.27	1	.27	.63	ns
group x text	.03	1	.03	.06	ns
version x group x text	.54	1	.54	1.27	ns
Within subjects + residual	9.56	22	.43		
general vs specific (gen\spec)	11.94	1	11.94	27.48	.000
version x gen\spec	1.27	1	1.27	2.93	ns
group x gen\spec	.00	1	.00	.01	ns
version x group x gen\spec	.05	1	.05	.12	ns
Within subjects + residual	13.35	44	.30		
positive vs negative vs neutral monitoring	3.31	2	1.66	5.46	.002
version x pos\neg\neut	4.37	2	2.18	7.19	.002
group x pos\neg\neut	1.46	2	.73	2.41	ns
version x group x pos\neg\neut	2.08	2	1.04	3.43	.041
Within subjects + residual	7.28	22	.33		
text x gen\spec	.22	1	.22	.65	ns
version x text x gen\spec	.01	1	.01	.03	ns
group x text x gen\spec	1.15	1	1.15	3.49	.075
version x group x text x gen\spec	.13	1	.13	.39	ns
Within subjects + residual	11.84	44	.27		
text x pos\neg\neut	.57	2	.29	1.06	ns
version x text x pos\neg\neut	2.42	2	1.21	4.49	.017
group x text x pos\neg\neut	2.43	2	1.22	4.52	.016
version x group x text x pos\neg\neut	1.07	2	.54	1.99	ns
Within subjects + residual	8.62	44	.20		
gen\spec x pos\neg\neut	1.55	2	.77	3.96	.026
version x gen\spec x pos\neg\neut	1.91	2	.95	4.87	.012
group x gen\spec x pos\neg\neut	.76	2	.38	1.93	ns
version x group x gen\spec \ pos\neg\neut	.63	2	.31	1.61	ns
Within subjects + residual	12.84	44	.29		
text x gen\spec x pos\neg\neut	.16	2	.08	.27	ns
version x text x gen\spec x pos\neg\neut	.29	2	.14	ns	
group x text x gen\spec x pos\neg\neut	1.31	2	.65	2.24	ns
version x group x text x gen\spec x pos\neg\neut	.64	2	.32	1.10	ns

Table A2.23 **Effects of text version on comprehension strategy use in year 1.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of strategy** (strategy). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	132.21	22	6.01		
text version (version)	4.20	1	4.20	.70	ns
group	33.75	1	33.75	5.62	.027
version x group	1.17	1	1.17	.20	ns
Within subjects + residual	12.99	22	.59		
text familiarity (text)	.01	1	.01	.02	ns
version x text	.00	1	.00	.00	ns
group x text	.28	1	.28	.47	ns
version x group x text	1.78	1	1.78	3.01	.097
Within subjects + residual	382.30	110	3.48		
type of strategy	169.00	5	33.80	9.73	.000
version x strategy	13.12	5	2.62	.75	ns
group x strategy	75.42	5	15.08	4.34	.001
version x group x strategy	3.46	5	.69	.20	ns
Within subjects + residual	58.82	110	.53		
text x strategy	1.15	5	.23	.43	ns
version x text x strategy	2.77	5	.55	1.04	ns
group x text x strategy	1.52	5	.30	.57	ns
version x group x text x strategy	9.63	5	1.93	3.60	.005

Table A2.24 **Effects of text version on comprehension ratings in year 1.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	12.99	19	.68		
text version (version)	2.98	1	2.98	4.35	.051
group	1.43	1	1.43	2.09	ns
version x group	.21	1	.21	.30	ns
Within subjects + residual	13.29	19	.70		
text familiarity (text)	.00	1	.00	.00	ns
version x text	.59	1	.59	.84	ns
group x text	.42	1	.42	.60	ns
version x group x text	.03	1	.03	.04	ns

Table A2.25 **Effects of text version on the range of comprehension strategies used in year 1.** Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	72.79	22	3.31		
text version (version)	.46	1	.46	.14	ns
group	15.75	1	15.75	4.76	.040
version x group	.06	1	.06	.02	ns
Within subjects + residual	20.44	22	.93		
text familiarity (text)	.40	1	.40	.44	ns
version x text	4.71	1	4.71	5.07	.035
group x text	4.16	1	4.16	4.48	.046
version x group x text	.00	1	.00	.00	ns

Table A2.26 **Effects of text version on inferences in year 1.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of inference** (infer). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	1831.44	22	83.25		
text version (version)	37.13	1	37.13	.45	ns
group	501.93	1	501.93	6.03	.022
version x group	96.93	1	93.93	1.16	ns
Within subjects + residual	147.92	22	6.72		
text familiarity (text)	.95	1	.95	.14	ns
version x text	8.95	1	8.95	1.33	.261
group x text	5.63	1	5.63	.84	.370
version x group x text	16.63	1	16.63	2.47	ns
Within subjects + residual	1276.37	22	58.02		
type of inference (infer)	1699.59	1	1699.59	29.29	.000
version x infer	8.59	1	8.59	.15	ns
group x infer	396.93	1	396.93	6.84	.016
version x group x infer	96.93	1	96.93	1.67	ns
Within subjects + residual	127.89	22	5.81		
text x infer	.11	1	.11	.02	ns
version x text x infer	.03	1	.03	.01	ns
group x text x infer	.58	1	.58	.10	ns
version x group x text x infer	1.50	1	1.50	.26	ns

Table A2.27 **Effects of text version on comprehension monitoring in year 2.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); main effect of **general vs specific monitoring** (gen\spec); and main effect of **positive vs. negative vs. neutral monitoring** (pos\neg\neut). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	99.27	17	5.84		
text version (version)	7.61	1	7.61	1.30	ns
group	.87	1	.87	.15	ns
version x group	10.80	1	10.80	1.85	ns
Within subjects + residual	18.34	17	1.08		
text familiarity (text)	7.01	1	7.01	6.50	.021
version x text	3.37	1	3.37	3.12	.095
group x text	1.77	1	1.77	1.64	ns
version x group x text	1.09	1	1.09	1.01	.329
Within subjects + residual	55.67	17	3.27		
general vs specific (gen\spec)	86.23	1	86.23	26.33	.000
version x gen\spec	8.10	1	8.10	2.47	ns
group x gen\spec	1.23	1	1.23	.38	ns
version x group x gen\spec	4.22	1	4.22	1.29	ns
Within subjects + residual	80.57	34	2.37		
positive vs negative vs neutral monitoring	86.69	2	43.34	18.29	.000
version x pos\neg\neut	2.92	2	1.46	.62	ns
group x pos\neg\neut	.40	2	.20	.08	ns
version x group x pos\neg\neut	14.52	2	7.26	3.06	.060
Within subjects + residual	19.20	17	1.13		
text x gen\spec	5.08	1	5.08	4.49	.049
version x text x gen\spec	2.90	1	2.90	2.57	.ns
group x text x gen\spec	2.98	1	2.98	2.64	ns
version x group x text x gen\spec	1.38	1	1.38	1.22	ns
Within subjects + residual	50.01	34	1.47		
text x pos\neg\neut	39.01	2	19.50	13.26	.000
version x text x pos\neg\neut	14.73	2	7.37	5.01	.012
group x text x pos\neg\neut	2.27	2	1.14	.77	ns
version x group x text x pos\neg\neut	.44	2	.22	.15	ns
Within subjects + residual	30.81	34	.91		
gen\spec x pos\neg\neut	44.91	2	22.45	24.78	.000
version x gen\spec x pos\neg\neut	1.85	2	.92	1.02	ns
group x gen\spec x pos\neg\neut	.64	2	.32	.35	ns
version x group x gen\spec \ pos\neg\neut	5.21	2	2.60	2.87	.070
Within subjects + residual	58.24	34	1.71		
text x gen\spec x pos\neg\neut	26.44	2	13.22	7.72	.002
version x text x gen\spec x pos\neg\neut	17.70	2	8.85	5.17	.011
group x text x gen\spec x pos\neg\neut	4.47	2	2.23	1.30	ns
version x group x text x gen\spec x pos\neg\neut	.56	2	.28	.16	ns

Table A2.28 **Effects of text version on comprehension strategy use in year 2.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of strategy** (strategy). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	183.77	17	10.81		
text version (version)	13.15	1	13.15	1.22	ns
group	14.13	1	14.13	1.31	ns
version x group	28.53	1	28.53	2.64	ns
Within subjects + residual	30.07	17	1.77		
text familiarity (text)	6.28	1	6.28	3.55	.077
version x text	5.63	1	5.63	3.19	.092
group x text	15.65	1	15.65	8.85	.008
version x group x text	2.10	1	2.10	1.19	ns
Within subjects + residual	521.67	85	6.14		
type of strategy (strategy)	349.34	5	69.87	11.38	.000
version x strategy	14.18	5	2.84	.46	ns
group x strategy	36.58	5	7.32	1.19	ns
version x group x strategy	79.26	5	15.85	2.58	.032
Within subjects + residual	97.63	85	1.15		
text x strategy	11.67	5	2.33	2.03	.082
version x text x strategy	16.70	5	3.34	2.91	.018
group x text x strategy	20.87	5	4.17	3.63	.005
version x group x text x strategy	.96	5	.19	.17	ns

Table A2.29 **Effects of text version on comprehension ratings in year 2.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	18.42	17	1.08		
text version (version)	.21	1	.21	.19	ns
group	2.04	1	2.04	1.88	ns
version x group	.26	1	.26	.24	ns
Within subjects + residual	6.42	17	.38		
text familiarity (text)	16.09	1	16.09	42.62	.000
version x text	1.34	1	1.34	3.55	.077
group x text	1.22	1	1.22	3.23	.090
version x group x text	.04	1	.04	.09	ns

Table A2.30 **Effects of text version on the range of comprehension strategies used in year 2.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	106.82	17	6.28		
text version (version)	10.26	1	10.26	1.63	
group	34.12	1	34.12	5.43	.032
version x group	4.99	1	4.99	.79	ns
Within subjects + residual	35.35	17	2.08		
text familiarity (text)	1.10	1	1.10	.53	ns
version x text	1.47	1	1.47	.71	ns
group x text	7.10	1	7.10	3.42	.082
version x group x text	.79	1	.79	.38	ns

Table A2.31 **Effects of text version on inferences in year 2.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of inference** (infer). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	4711.13	17	277.13		
text version (version)	28.41	1	28.41	.10	ns
group	742.98	1	742.98	2.68	ns
version x group	253.22	1	253.22	.91	ns
Within subjects + residual	359.90	17	21.17		
text familiarity (text)	9.51	1	9.51	.45	ns
version x text	15.98	1	15.98	.75	ns
group x text	26.41	1	26.41	1.25	ns
version x group x text	.12	1	.12	.01	ns
Within subjects + residual	2739.53	17	161.15		
type of inference (infer)	1950.14	1	1950.14	12.10	.003
version x infer	20.18	1	20.18	.13	ns
group x infer	913.68	1	913.68	5.67	.029
version x group x infer	.37	1	.37	.00	ns
Within subjects + residual	528.83	17	31.11		
text x infer	141.98	1	141.98	4.56	.047
version x text x infer	12.00	1	12.00	.39	ns
group x text x infer	50.68	1	50.68	1.63	ns
version x group x text x infer	7.31	1	7.31	.23	ns

Table A2.32 **Effects of text version on comprehension monitoring in year 3.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); main effect of **general vs specific monitoring** (gen\spec); and main effect of **positive vs. negative vs. neutral monitoring** (pos\neg\neut). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	16.56	8	2.07		
text version (version)	4.80	1	4.80	2.32	ns
group	11.49	1	11.49	5.55	.046
version x group	.11	1	.11	.05	ns
Within subjects + residual	4.11	8	.51		
text familiarity (text)	.00	1	.00	.01	ns
version x text	.94	1	.94	1.84	ns
group x text	.79	1	.79	1.54	ns
version x group x text	.94	1	.94	1.84	ns
Within subjects + residual	14.29	8	1.79		
general vs specific (gen\spec)	28.89	1	28.89	16.17	.004
version x gen\spec	6.15	1	6.15	3.44	ns
group x gen\spec	9.62	1	9.62	5.38	.049
version x group x gen\spec	1.07	1	1.07	.60	ns
Within subjects + residual	25.97	16	1.62		
positive vs negative vs neutral monitoring	.53	2	.27	.16	ns
version x pos\neg\neut	2.31	2	1.16	.71	ns
group x pos\neg\neut	.67	2	.34	.21	ns
version x group x pos\neg\neut	.88	2	.44	.27	ns
Within subjects + residual	4.78	8	.60		
text x gen\spec	.31	1	.31	.52	ns
version x text x gen\spec	.23	1	.23	.38	ns
group x text x gen\spec	1.92	1	1.92	3.21	ns
version x group x text x gen\spec	.23	1	.23	.38	ns
Within subjects + residual	12.57	16	.79		
text x pos\neg\neut	2.47	2	1.24	1.57	ns
version x text x pos\neg\neut	1.79	2	.89	1.14	ns
group x text x pos\neg\neut	4.45	2	2.23	2.84	ns
version x group x text x pos\neg\neut	.15	2	.07	.09	ns
Within subjects + residual	30.63	16	1.91		
gen\spec x pos\neg\neut	2.57	2	1.28	.67	ns
version x gen\spec x pos\neg\neut	2.43	2	1.22	.63	ns
group x gen\spec x pos\neg\neut	1.51	2	.75	.39	ns
version x group x gen\spec \ pos\neg\neut	.00	2	.00	.00	ns
Within subjects + residual	14.30	16	.89		
text x gen\spec x pos\neg\neut	.99	2	.50	.56	ns
version x text x gen\spec x pos\neg\neut	1.95	2	.98	1.09	ns
group x text x gen\spec x pos\neg\neut	2.16	2	1.08	1.21	ns
version x group x text x gen\spec x pos\neg\neut	.31	2	.16	.17	ns

Table A2.33 **Effects of text version on comprehension strategy use in year 3.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of strategy** (strategy). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	63.77	8	7.97		
text version (version)	4.02	1	4.02	.50	ns
group	4.89	1	4.89	.61	ns
version x group	.79	1	.79	.10	ns
Within subjects + residual	30.77	8	3.85		
text familiarity (text)	5.46	1	5.46	1.42	ns
version x text	1.70	1	1.70	.44	ns
group x text	.02	1	.02	.01	ns
version x group x text	1.39	1	1.39	.36	ns
Within subjects + residual	292.17	40	7.30		
type of strategy (strategy)	127.63	5	25.53	3.49	.010
version x strategy	36.64	5	7.33	1.00	ns
group x strategy	16.79	5	3.36	.46	ns
version x group x strategy	24.23	5	4.85	.66	ns
Within subjects + residual	68.78	40	1.72		
text x strategy	37.76	5	7.55	4.39	.003
version x text x strategy	2.70	5	.54	.31	ns
group x text x strategy	1.91	5	.38	.22	ns
version x group x text x strategy	14.54	5	2.91	1.69	ns

Table A2.34 **Effects of text version on comprehension ratings in year 3.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	4.15	8	.52		
text version (version)	2.63	1	2.63	5.06	.055
group	.01	1	.01	.02	ns
version x group	.01	1	.01	.02	ns
Within subjects + residual	1.75	8	.22		
text familiarity (text)	1.03	1	1.03	4.69	.062
version x text	.00	1	.00	.00	ns
group x text	.26	1	.26	1.17	ns
version x group x text	.26	1	.26	1.17	ns

Table A2.35 **Effects of text version on the range of comprehension strategies used in year 3.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	38.40	8	4.80		
text version (version)	17.24	1	17.24	3.59	.095
group	15.60	1	15.60	3.25	ns
version x group	8.63	1	8.63	1.80	ns
Within subjects + residual	25.40	8	3.18		
text familiarity (text)	.37	1	.37	.12	ns
version x text	2.01	1	2.01	.63	ns
group x text	.16	1	.16	.05	ns
version x group x text	.16	1	.16	.05	ns

Table A2.36 **Effects of text version on inferences in year 3.**
Analysis of variance with between subjects factor of **text version** (version 1 texts vs. version 2 texts); between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of inference** (infer). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	3057.51	8	382.19		
text version (version)	93.12	1	93.12	.24	ns
group	.00	1	.00	.00	ns
version x group	59.54	1	59.54	.16	ns
Within subjects + residual	40.51	8	5.06		
text familiarity (text)	.54	1	.54	.11	ns
version x text	2.54	1	2.54	.50	ns
group x text	.27	1	.27	.05	ns
version x group x text	.12	1	.12	.02	ns
Within subjects + residual	2442.01	8	305.25		
type of inference (infer)	1412.12	1	1412.12	4.63	.064
version x infer	119.65	1	119.65	.39	ns
group x infer	.31	1	.31	.00	ns
version x group x infer	18.31	1	18.31	.06	ns
Within subjects + residual	121.11	8	15.14		
text x infer	.44	1	.44	.03	ns
version x text x infer	.90	1	.90	.06	
group x text x infer	4.09	1	4.09	.27	ns
version x group x text x infer	1.27	1	1.27	.08	ns

Table A2.37 Analysis of variance of **comprehension strategies** with between subjects factor of **group** (good vs. poor learners identified from reported LASSI ratings); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of strategy** (strategy). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	648.11	28	23.15		
group	60.21	1	60.21	2.60	ns
Within subjects + residual	238.58	56	4.26		
year	24.01	2	12.01	2.82	.068
group x year	.74	2	.37	.09	ns
Within subjects + residual	73.43	28	2.62		
text familiarity (text)	3.45	1	3.45	1.31	ns
group x text	.49	1	.49	.19	ns
Within subjects + residual	1341.05	140	9.58		
strategy	1143.99	5	228.80	23.89	.000
group x strategy	65.21	5	13.04	1.36	ns
Within subjects + residual	138.69	56	2.48		
year x text	3.68	2	1.84	.74	ns
group x year x text	2.19	2	1.10	.44	ns
Within subjects + residual	1036.60	280	3.70		
year x strategy	62.21	10	6.22	1.68	.085
group x year x strategy	22.19	10	2.22	.60	ns
Within subjects + residual	237.42	140	1.70		
text x strategy	23.64	5	4.73	2.79	.020
group x text x strategy	14.75	5	2.95	1.74	ns
Within subjects + residual	420.67	280	1.50		
year x text x strategy	9.99	10	1.00	.66	ns
group x year x text x strategy	23.12	10	2.31	1.54	ns

Table A2.38 Analysis of variance of **mean number of different strategies used** with between subjects factor of **group** (good vs. poor learners identified from reported LASSI ratings); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and within subjects factor of **text familiarity** (familiar vs. unfamiliar). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	368.33	28	13.15		
group	54.45	1	54.45	4.14	.051
Within subjects + residual	115.93	56	2.07		
year	16.30	2	8.15	3.94	.025
group x year	4.43	2	2.22	1.07	ns
Within subjects + residual	39.22	28	1.40		
text familiarity (text)	.01	1	.01	.00	ns
group x text	2.94	1	2.94	2.10	ns
Within subjects + residual	97.44	56	1.74		
year x text	.88	2	.44	.25	ns
group x year x text	1.01	2	.51	.29	ns

Table A2.39 Analysis of variance of **mean number of comprehension monitoring statements** with between subjects factor of **group** (good vs. poor learners identified from reported LASSI ratings); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **positive vs. negative vs. neutral monitoring** (pos\neg\neut). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	294.19	28	10.51		
group	24.49	1	24.49	2.33	ns
Within subjects + residual	212.24	56	3.79		
year	70.49	2	35.25	9.30	.000
group x year	8.16	2	4.08	1.08	ns
Within subjects + residual	77.34	28	2.76		
text familiarity (text)	11.56	1	11.56	4.18	.050
group x text	.05	1	.05	.02	ns
Within subjects + residual	283.50	56	5.06		
positive vs negative vs neutral (pos\neg\neut)	72.69	2	36.35	7.18	.002
group x pos\neg\neut	14.36	2	7.18	1.42	ns
Within subjects + residual	78.76	56	1.41		
year x text	8.38	2	4.19	2.98	.059
group x year x text	3.78	2	1.89	1.34	ns
Within subjects + residual	224.87	112	2.01		
year x pos\neg\neut	70.63	4	17.66	8.79	.000
group x year x pos\neg\neut	10.61	4	2.65	1.32	ns
Within subjects + residual	203.99	56	3.64		
text x pos\neg\neut	82.47	2	41.24	11.32	.000
group x text x pos\neg\neut	6.76	2	3.38	.93	ns
Within subjects + residual	181.81	112	1.62		
year x text x pos\neg\neut	54.54	4	13.64	8.40	.000
group x year x text x pos\neg\neut	1.10	4	.27	.17	ns

Table A2.40 Analysis of variance of **mean number of strategies used in comprehension episodes with negative monitoring** with between subjects factor of **group** (good vs. poor learners identified from reported LASSI ratings). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Year 1 familiar text					
between groups	1.78	1	1.78	.29	ns
within groups	73.42	12	6.11		
Year 1 unfamiliar text					
between groups	5.86	1	5.86	.94	ns
within groups	56.13	9	6.23		
Year 2 familiar text					
between groups	35.66	1	35.66	2.80	ns
within groups	190.45	15	12.69		
Year 2 unfamiliar text					
between groups	129.46	1	129.46	3.03	.09
within groups	1024.88	24	42.70		
Year 3 familiar text					
between groups	.11	1	.11	.00	ns
within groups	324.42	9	36.04		
Year 3 unfamiliar text					
between groups	60.16	1	60.16	1.67	ns
within groups	789.83	22	35.90		

Table A2.41 Analysis of variance of **mean number of inferences** with between subjects factor of **group** (good vs. poor learners identified from reported LASSI ratings); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of **type of inference** (warranted vs. unwarranted). Verbal protocols experiment.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	11700.42	28	417.87		
group	756.90	1	756.90	1.81	ns
Within subjects + residual	2345.64	56	41.89		
year	951.24	2	475.62	11.35	.000
group x year	183.95	2	91.98	2.20	ns
Within subjects + residual	337.36	28	12.05		
text familiarity (text)	20.54	1	20.54	1.71	ns
group x text	8.10	1	8.10	.67	ns
Within subjects + residual	9270.96	28	331.11		
type of inference	10562.50	1	10562.50	31.90	.000
group x type of inference	273.88	1	273.88	.83	ns
Within subjects + residual	458.78	56	8.19		
year x text	13.91	2	6.95	.85	ns
group x year x text	7.82	2	3.91	.48	ns
Within subjects + residual	2040.31	56	36.43		
year x type of inference	929.02	2	464.51	12.75	.000
group x year x type of inference	37.84	2	18.92	.52	ns
Within subjects + residual	384.87	28	13.75		
text x type of inference	72.90	1	72.90	5.30	.029
group x text x type of inference	4.90	1	4.90	.36	ns
Within subjects + residual	549.27	56	9.81		
year x text x type of inference	33.95	2	16.98	1.73	ns
group x year x text x type of inference	31.62	2	15.81	1.61	ns

Table A3.1 Motivated Strategies for Learning Questionnaire (MSLQ).

(A) Motivation Scales

(1) Value components

(i) Intrinsic Goal orientation

1. In a class like this, I prefer course material that really challenges me so I can learn new things.
16. In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.
22. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.
24. When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade.

(ii) Extrinsic Goal Orientation

7. Getting a good grade in this class is the most satisfying thing for me right now.
11. The most important thing for me right now is improving my overall average mark, so my main concern in this class is getting a good grade.
13. If I can, I want to get better grades in this class than most of the other students.
30. I want to do well in this class because it is important to show my ability to my family, friends, employer or others.

(iii) Task Value

4. I think I will be able to use what I learn in this course in other courses.
10. It is important for me to learn the course material in this class.
17. I am very interested in the content area of this course.
23. I think the course material in this class is useful for me to learn.
26. I like the subject matter of this course.
27. Understanding the subject matter of this course is very important to me.

(2) Expectancy components

(i) Control of Learning Beliefs

2. If I study in appropriate ways, then I will be able to learn the material in this course.
9. It is my own fault if I don't learn the material in this course.
18. If I try hard enough, then I will understand the course material.
25. If I don't understand the course material, it is because I didn't try hard enough.

(ii) Self-Efficacy for Learning and Performance

5. I believe I will receive an excellent grade in this class.
6. I'm certain I can understand the most difficult material presented in the readings for this course.
12. I'm confident I can learn the basic concepts taught in this course.
15. I'm confident I can understand the most complex material presented by the instructor in this course.
20. I'm confident I can do an excellent job on the assignments and tests in this course.
21. I expect to do well in this class.
29. I'm certain I can master the skills being taught in this class.
31. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.

(3) Affective component

(i) Test Anxiety

3. When I take a test I think about how poorly I am doing compared with other students.
8. When I take a test I think about items on other parts of the test I can't answer.
14. When I take tests, I think of the consequences of failing.
19. I have an uneasy, upset feeling when I take an exam.
28. I feel my heart bearing fast when I take an exam.

(B) Learning strategies scales

(i) Cognitive and Metacognitive Strategies

(i) Rehearsal

39. When I study for this class, I practice saying the material to myself over and over.
46. When studying for this class, I read my class notes and the course readings over and over again.
59. I memorize key words to remind me of important concepts in this class.
72. I make lists of important terms for this course and memorize the lists.

(ii) Elaboration

53. When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.
62. I try to relate ideas in this subject to those in other courses whenever possible.
64. When reading for this class, I try to relate the material to what I already know.
67. When I study for this course, I write brief summaries of the main ideas from the readings and the concepts from the lectures.
69. I try to understand the material in this class by making connections between the readings and the concepts from the lectures.
81. I try to apply ideas from course readings in other class activities such as lectures and discussion.

(iii) Organization

32. When I study the readings for this course, I outline the material to help me organize my thoughts.
42. When I study for this course, I go through the readings and my class notes and try to find the most important ideas.
49. I make simple charts, diagrams, or tables to help me organize course material.
63. When I study for this course, I go over my class notes and make an outline of important concepts.

(iv) Critical Thinking

38. I often find myself questioning things I hear or read in this course to decide if I find them convincing.
47. When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence.
51. I treat the course material as a starting point and try to develop my own ideas about it.
66. I try to play around with ideas of my own related to what I am learning in this course.
71. Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.

(v) **Metacognitive Self-Regulation**

33. During class time I often miss important points because I'm thinking or other things. (REVERSED)
36. When reading for this course, I make up questions to help focus my reading.
41. When I become confused about something I'm reading for this class, I go back and try to figure it out.
44. If course materials are difficult to understand, I change the way I read the material.
54. Before I study new course material thoroughly, I often skim it to see how it's organized.
55. I ask myself questions to make sure I understand the material I have been studying in this class.
56. I try to change the way I study in order to fit the course requirements and instructor's teaching style.
57. I often find that I have been reading for class but don't know what it was about. (REVERSED)
61. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.
76. When studying for this course I try to determine which concepts I don't understand well.
78. When I study for this class, I set goals for myself in order to direct my activities in each study period.
79. If I get confused taking notes in class, I make sure I sort it out afterwards.

(ii) Resource Management scale

(i) **Time and Study Environment**

35. I usually study in a place where I can concentrate on my course work.
43. I make good use of my study time for this course.
52. I find it hard to stick to a study schedule. (REVERSED)
65. I have a regular place set aside for studying.
70. I make sure I keep up with the weekly readings and assignments for this course.
73. I attend class regularly.
77. I often find that I don't spend very much time on this course because of other activities. (REVERSED)
80. I rarely find time to review my notes or readings before an exam.

(ii) **Effort Regulation**

37. I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do. (REVERSED)
48. I work hard to do well in this class even if I don't like what we are doing.
60. When course work is difficult, I give up or only study the easy parts. (REVERSED)
74. Even when course materials are dull and uninteresting, I manage to keep working until I finish.

(iii) **Peer Learning**

34. When studying for this course, I often try to explain the material to a classmate or friend.
45. I try to work with other students from this class to complete the course assignments.
50. When studying for this course, I often set aside time to discuss the course material with a group of students from this class.

(iv) **Help Seeking**

40. Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone. (REVERSED)
58. I ask the instructor to clarify concepts I don't understand well.
68. When I can't understand the material in this course, I ask another student in this class for help.
75. I try to identify students in this class whom I can ask for help if necessary.

Table A3.2 Analysis of variance of **LASSI motivation scores** with between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor or **year** (year 1 vs. year 2 vs. year 3). Motivation (MSLQ) study.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	1521.99	23	66.17		
group	153.93	1	153.93	2.33	ns
Within subjects + residual	289.94	46	6.30		
year	34.27	2	17.13	2.72	.077
group x year	4.78	2	2.39	.38	ns

Table A3.3 Analysis of variance of **Value components of the MSLQ** (intrinsic goal orientation (IGO); extrinsic goal orientation (EGO); and task value) with between subjects factor of **group** (good vs. poor learners identified by exam performance) and main effect of **type of value component** (IGO, EGO or task value). Motivation (MSLQ) study.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	55.68	23	2.42		
group	3.37	1	3.37	1.39	ns
Within subjects + residual	52.60	46	1.14		
type of value	1.49	2	.74	.65	ns
group x type of value	8.32	2	4.16	3.64	.034

Table A3.4 Analysis of variance of **Expectancy components of the MSLQ** (self-efficacy beliefs and control beliefs) with between subjects factor of **group** (good vs. poor learners identified by exam performance) and main effect of **type of value component** (self-efficacy beliefs or control beliefs). Motivation (MSLQ) study.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	33.66	23	1.46		
group	1.27	1	1.27	.87	ns
Within subjects + residual	14.11	23	.61		
type of value	13.56	1	13.56	22.11	.000
group x type of value	.20	1	.20	.33	ns

Table A3.5 Analysis of variance of **Test Anxiety component of the MSLQ** with between subjects factor of **group** (good vs. poor learners identified by exam performance). Motivation (MSLQ) study.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Between groups differences	1.55	1	1.55	.54	ns
Within groups differences	65.91	23	2.86		

Table A3.6 Analysis of variance of **Cognitive and Metacognitive strategies of the MSLQ** with between subjects factor of **group** (good vs. poor learners identified by exam performance) and main effect of **type of strategy** (rehearsal, elaboration, organisation, critical thinking, and metacognitive self-regulation). Motivation (MSLQ) study.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	75.57	23	3.29		
group	9.45	1	9.45	2.88	ns
Within subjects + residual	51.56	92	.56		
type of strategy	17.79	4	4.45	7.94	.000
group x type of strategy	1.30	4	.33	.58	ns

Table A3.7 Analysis of variance of **Resource management strategies of the MSLQ** with between subjects factor of **group** (good vs. poor learners identified by exam performance) and main effect of **type of strategy** (time & study, effort regulation, peer learning and help seeking). Motivation (MSLQ) study.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	83.05	23	3.61		
group	10.94	1	10.94	3.03	.095
Within subjects + residual	73.17	69	1.06		
type of strategy	102.76	3	34.25	32.30	.000
group x type of strategy	1.30	3	.43	.41	ns

Table A4.1 Analysis of variance of the **3 clusters** identified from the reported ratings of strategy use with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and main effect of type of cluster (Cluster 1, 2 or 3) Chapter 3: Metacognitive knowledge of strategies.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	19.09	23	.83		
group	1.01	1	1.01	1.21	ns
Within subjects + residual	4.21	46	.09		
year	.70	2	.35	3.81	.029
group x year	.76	2	.38	4.14	.022
Within subjects + residual	6.79	46	.15		
type of cluster	29.64	2	14.82	100.46	.000
group x cluster	.78	2	.39	2.64	.082
Within subjects + residual	4.96	92	.05		
year x type of cluster	.16	4	.04	.76	ns
group x year x type of cluster	.35	4	.09	1.62	ns

Table A4.2 Analysis of variance of the **strategies in cluster 1** identified from the reported ratings of strategy use with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and main effect of type of strategy (important points, underline, define unfamiliar terms, summary, re-read and take notes). Chapter 3: Metacognitive knowledge of strategies.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	44.52	23	1.94		
group	7.76	1	7.76	4.01	.057
Within subjects + residual	17.11	46	.37		
year	1.19	2	.59	1.60	ns
group x year	2.95	2	1.47	3.96	.026
Within subjects + residual	48.92	115	.43		
type of strategy	8.37	5	1.67	3.94	.002
group x type of strategy	.96	5	.19	.45	ns
Within subjects + residual	42.25	230	.18		
year x type of strategy	2.20	10	.22	1.20	ns
group x year x type of strategy	1.14	10	.11	.62	ns

Table A4.3 Analysis of variance of the **strategy of linking text to prior knowledge** identified from the reported ratings of strategy use with between subjects factor of **group** (good vs. poor learners identified by exam performance); and within subjects factor or **year** (year 1 vs. year 2 vs. year 3). Chapter 3: Metacognitive knowledge of strategies.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	9.28	23	.40		
group	.24	1	.24	.60	ns
Within subjects + residual	11.11	46	.24		
year	.04	2	.02	.07	ns
group x year	1.53	2	.76	3.16	.052

Table A4.4 Analysis of variance of the **strategies in cluster 2** identified from the reported ratings of strategy use with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and main effect of type of strategy (identify unfamiliar terms, monitor, outline, question, use information and restatement). Chapter 3: Metacognitive knowledge of strategies.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	55.16	22	2.51		
group	2.91	1	2.91	1.16	ns
Within subjects + residual	19.60	44	.45		
year	3.12	2	1.56	3.50	.039
group x year	2.43	2	1.22	2.73	.076
Within subjects + residual	54.10	110	.49		
type of strategy	18.12	5	3.62	7.37	.000
group x type of strategy	2.49	5	.50	1.01	ns
Within subjects + residual	60.12	220	.27		
year x type of strategy	2.21	10	.22	.81	ns
group x year x type of strategy	3.51	10	.35	1.28	ns

Table A4.5 Analysis of variance of the **strategies of looking for logical relations and getting the gist** identified from the reported ratings of strategy use with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3) and main effect of type of strategy (logic vs. gist). Chapter 3: Metacognitive knowledge of strategies.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	31.32	23	1.36		
group	.66	1	.66	.48	ns
Within subjects + residual	20.64	46	.45		
year	.85	2	.43	.95	ns
group x year	.19	2	.09	.21	ns
Within subjects + residual	6.60	23	.29		
type of strategy	.07	1	.07	.24	ns
group x type of strategy	.18	1	.18	.61	ns
Within subjects + residual	7.86	46	.17		
year x type of strategy	.84	2	.42	2.45	.098
group x year x type of strategy	.97	2	.48	2.84	.069

Table A4.6 Analysis of variance of the **strategies in cluster 3** identified from the reported ratings of strategy use with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor or **year** (year 1 vs. year 2 vs. year 3); and main effect of type of strategy (linking text to emotions, to beliefs, to experiences, predicting text, drawing diagrams and challenging the author). Chapter 3: Metacognitive knowledge of strategies.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	55.78	23	2.43		
group	.05	1	.05	.02	ns
Within subjects + residual	17.32	46	.38		
year	.81	2	.40	1.07	ns
group x year	.91	2	.46	1.21	ns
Within subjects + residual	52.53	115	.46		
type of strategy	5.45	5	1.09	2.39	.042
group x type of strategy	.44	5	.09	.19	ns
Within subjects + residual	51.75	230	.23		
year x type of strategy	1.34	10	.13	.60	ns
group x year x type of strategy	10	.19	.19	.86	ns

Table A4.7 Analysis of variance of the **strategy of reading ahead** identified from the reported ratings of strategy use with between subjects factor of **group** (good vs. poor learners identified by exam performance) and within subjects factor or **year** (year 1 vs. year 2 vs. year 3). Chapter 3: Metacognitive knowledge of strategies.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	17.06	22	.78		
group	.89	1	.89	1.15	ns
Within subjects + residual	15.94	44	.36		
year	1.19	2	.60	1.65	ns
group x year	.19	2	.10	.27	ns

Table A6.1 Prior knowledge, textbase and inference questions used with the familiar version 1 text.

A. *Familiar prior knowledge questions (used with version 1 text)*

1. What is the difference between deductive and inductive reasoning?
2. Syntactic theories propose that the process of reasoning is error-free. Where, according to syntactic theories, do errors arise from?
3. How does mental models theory different from a rule (syntactic) theory of deduction?
4. What is a syllogism?
5. What does the atmosphere hypothesis propose?
6. What does the conversion hypothesis propose?
7. What is the Modus Tollens inference?
8. Johnson-Laird & Byrne (1989) investigated the use of "only" in syllogistic reasoning (i.e. *only* criminals are psychopaths). They predicted that people's mental representations of *only* would be more complex than *all*. Why would this be so?

B. *Textbase questions on familiar version 1 text: reasoning*

1. Because even the most intelligent people have difficulty with certain syllogisms, they are motivated to ....
2. When Aristotle invented logic, what did his method try to determine?
3. If the form of a set of true premises can lead to false conclusions , then the inference must be ....
4. Instead of searching for counter-examples of premises to conclusions, what did Aristotle do?
5. What is the major advantage of natural mental models over Euler circles and Venn diagrams?
6. What is the logical property of the relational expression *father of* ?
7. What is the logical property of the relational expression *not greater than* ?
8. What is a transitive inference?

C. *Bridging inference questions on familiar version 1 text: reasoning*

1. Why do human reasoners often fail to be rational?
2. Why is the theory of explicit inference based on mental models compatible with the development of logic?
3. Aristotle changed the content of premises whilst holding their form constant. Why did he do this?
4. According to mental model theory, the search for alternative 'counter-example' models of the premises should be .... and .... for the conclusion to be valid.
5. Explain the logical properties of the relational expression *greater than.*
6. Explain the logical properties of the relational expression *next to.*
7. The theory of mental models assumes reasoning depends on 3 main stages. Describe these 3 stages.
8. What relational expression could be represented in the general form:

   xRy and xRz $\therefore$ xRz ?

Table A6.2 **Prior knowledge, textbase and inference questions used with the familiar version 2 text.**

A. Familiar prior knowledge questions (used with version 2 text)

1. What sort of a representation is best able to explain the rapid retrieval of relevant general knowledge during language comprehension?
2. What sort of representation is a script?
3. What kinds of inferences are made during language comprehension?
4. What do frames represent?
5. What do scripts represent?
6. Schank (1982) revised his notion of scripts to make the knowledge structure more flexible, organizing actions at a more abstract level into what he calls ....
7. What problems have been identified with frames and scripts?
8. Global structure refers to the overall gist of a passage. Van Dijk and Kintsch propose that readers extract .... to represent main themes and topics in order to build up a .... for the whole text.

B. Textbase questions on familiar version 2 text: coherence & plausibility

1. What did story grammars fail to account for?
2. When people reconstruct the order of a passage of prose, they make use of cues about both .... and ....
3. Why must coherence be distinguished from plausibility in discourse?
4. What does the possession of a script allow a speaker to do?
5. What, according to Grice (1975) is it necessary to describe in discourse?
6. What is the main difficulty with the doctrine of scripts?
7. The properties and relations ascribed to referents must be ....
8. There is still much work to be done to explain the .... underlying the plausibility of a discourse.

C. Bridging inference questions on familiar version 2 text: coherence & plausibility

1. Why must each sentence in a discourse refer to an entity introduced in another sentence?
2. Which alternative hypothesis to story grammars was proposed to account for the structure of discourse?
3. What distinction was made between narrative and descriptive texts?
4. Why does the possibility of constructing a single mental model depend upon consistency?
5. What problems was Schank (1980) sensitive to?
6. Schank and Abelson have written computer programs about what kind of scripts?
7. How did Miller and Johnson-Laird (1976) describe the framework that plausibility depended upon?
8. The text described Kafka's "The Trial" as the original script for which type of encounters?

Table A6.3 **Prior knowledge, textbase and inference questions used with the unfamiliar version 1 text.**

A. Unfamiliar prior knowledge questions (used with both version 1 and version 2 texts)

1. Miller & Johnson-Laird (1976) distinguished between the "core" or a concept and "identification procedure". Briefly explain these terms.
2. What evidence is consistent with the hypothesis that decomposition of lexical items is part of the process of comprehension?
3. How does Johnson-Laird claim that the meanings of words are combined to form the meanings of the sentence?
4. How are the meanings of words represented in memory?
5. How have meaning postulates been used in theories of language comprehension?
6. What is the difference between "sense" and "reference"?
7. Do theories which assume that word meanings are represented as semantic features explain the "sense" or the "reference" of a sentence or both?
8. What is it that you know when you understand the meaning of a sentence?

B. Textbase Questions on unfamiliar version 1 text: lexical decomposition

1. The semantic representation of a word primarily comprises a structured set of elements, called ....
2. Ultimately, meanings are decomposable into ....
3. There is no reason to suppose that the latency to make up a sentence should be affected by ....
4. What was concluded about the use of the word bachelor compared to the word unmarried?
5. What did Fodor, Garrett, Walker & Parkes (1980) fail to find evidence for?
6. The representations are combined according to ....
7. The negative findings suggest that decomposition ....
8. Kintsch (1974) was unable to find any effects of ....

C. Bridging Inference Questions on unfamiliar version 1 text: lexical decomposition

1. State the version of the compositional principle discussed in the text.
2. Kintsch's experimental task and Fodor, Garrett, Walker and Parkes' (1980) experimental task were both criticized for the same reason. What was the reason?
3. Describe the idea that originated in the linguistic theory of Katz & Fodor (1963).
4. When the word bachelor occurred in place of not married, how did this affect the inference that was made?
5. Fodor, Fodor & Garrett's conclusion, that the representation of bachelor does not include a negative, may not be justified by a difference in latency response because ....
6. According to what plausible assumption should the sentence "A man lifts a boy" be harder to understand than the sentence "An adult lifts a child"?
7. How could Kintsch's finding be explained without giving up the idea of decomposition?
8. What do semantic markers do?

Table A6.4 Prior knowledge, textbase and inference questions used with the unfamiliar version 2 text.

A. Unfamiliar prior knowledge questions (used with both version 1 and version 2 texts)

The unfamiliar prior knowledge questions used with the version 1 unfamiliar text were also used with the version 2 unfamiliar text.

B. Textbase Questions on unfamiliar version 2 text: representation of meaning

1. According to Gibson (1971) what happens when a word is processed for meaning?
2. According to Fodor, Fodor & Garrett (1975) what happens when a word is processed for meaning?
3. In the authors experiment, what did the subjects have to detect?
4. In the author's experiment, the subjects listened to a list of thirty-six words and classified them as .... defined on the basis of ....
5. Where were definable words said to be acquired from?
6. Where were words that are not definable said to be acquired from?
7. What determines the amount of processing a word requires?
8. In the authors first experiment, which words were recalled with the lowest frequency?

C. Bridging Inference Questions on unfamiliar version 2 text: representation of meaning

1. Why did the author think that previous studies were unsatisfactory?
2. In the author's experiment, how was the target category defined, and what did the list contain?
3. How did the author manipulate the amount of processing of a word?
4. The evidence in the literature was said to be equivocal. What evidence was this?
5. What questions were asked about the way the semantic information of a word is organised?
6. When processing the semantic components of a word, what assessment is needed in order to reject words?
7. In the experiment, what was the trend found with the overall recall of words?
8. What were Graham Gibbs, Juliet de Mowbray and the author interested in?

Table A6.5 Analysis of variance of **main ideas in summaries** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **year** (year 1 vs. year 2 vs. year 3); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of type of idea (local, global, topic, incorrect and general). Chapter 6: Effects of Prior Knowledge.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	60.31	24	2.51		
group	5.42	1	5.42	2.16	ns
Within subjects + residual	59.53	48	1.24		
year	10.06	2	5.03	4.06	.024
group x year	1.20	2	.60	.48	ns
Within subjects + residual	22.48	24	.94		
text familiarity	8.00	1	8.00	8.54	.007
group x text familiarity	.16	1	.16	.17	ns
Within subjects + residual	230.58	96	2.40		
type of idea	152.91	4	38.23	15.92	.000
group x type of idea	35.04	4	8.76	3.65	.008
Within subjects + residual	19.37	48	.40		
year x text familiarity	.63	2	.32	.78	ns
group x year x text familiarity	2.26	2	1.13	2.81	.070
Within subjects + residual	325.03	192	1.69		
year x type of idea	27.90	8	3.49	2.06	.042
group x year x type of idea	2.94	8	.37	.22	ns
Within subjects + residual	118.22	96	1.23		
text familiarity x idea	18.56	4	4.64	3.77	.007
group x text fam x type of idea	4.43	4	1.11	.90	ns
Within subjects + residual	173.71	192	.90		
year x textfam x type of idea	6.94	8	.87	.96	ns
group x year x textfam x type of idea	5.75	8	.72	.79	ns

Table A6.6 Analysis of variance of **main ideas in summaries: FAMILIAR TEXTS ONLY;** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **year** (year 1 vs. year 2 vs. year 3); and main effect of type of idea (local, global, topic, incorrect and general). Chapter 6: Effects of Prior Knowledge.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	47.86	24	1.99		
group	3.70	1	3.70	1.86	ns
Within subjects + residual	28.79	48	.60		
year	2.84	2	1.42	2.36	ns
group x year	3.17	2	1.59	2.65	ns
Within subjects + residual	213.99	96	2.23		
type of idea	124.25	4	31.06	13.93	.000
group x type of idea	27.63	4	6.91	3.10	.019
Within subjects + residual	300.29	192	1.56		
year x type of idea	8.83	8	1.10	.71	ns
group x year x type of idea	3.42	8	.43	.27	ns

Table A6.7 Analysis of variance of **main ideas in summaries: UNFAMILIAR TEXTS ONLY;** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **year** (year 1 vs. year 2 vs. year 3); and main effect of type of idea (local, global, topic, incorrect and general). Chapter 6: Effects of Prior Knowledge.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	35.31	24	1.47		
group	2.01	1	2.01	1.37	ns
Within subjects + residual	46.32	48	.96		
year	5.83	2	2.92	3.02	.05
group x year	.25	2	.13	.13	ns
Within subjects + residual	131.41	96	1.37		
type of idea	68.83	4	17.21	12.57	.000
group x type of idea	14.96	4	3.74	2.73	.033
Within subjects + residual	211.27	192	1.10		
year x type of idea	32.02	8	4.00	3.64	.001
group x year x type of idea	4.31	8	.54	.49	ns

Table A6.8 Analysis of variance of **time taken to answer prior knowledge, textbase and inference questions** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of type of question (prior knowledge vs. textbase vs. inference). Chapter 6: Effects of Prior Knowledge.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	476086.81	10	47608.68		
group	26812.86	1	26812.86	.56	ns
Within subjects + residual	27324.94	10	2732.49		
text familiarity	2251.56	1	2251.56	.82	ns
group x text familiarity	12703.56	1	12703.56	4.65	.056
Within subjects + residual	184067.02	20	9203.35		
type of question	245680.31	2	122840.16	13.35	.000
group x type of question	9217.98	2	4608.99	.50	ns
Within subjects + residual	104554.54	20	5227.73		
text familiarity x type of question	7243.12	2	3621.56	.69	ns
group x text fam x type of question	152.12	2	76.06	.01	ns

Table A6.9 Analysis of variance of **correct answers to prior knowledge, textbase and inference questions** with between subjects factor of **group** (good vs. poor learners identified by exam performance); within subjects factor of **text familiarity** (familiar vs. unfamiliar); and main effect of type of question (prior knowledge vs. textbase vs. inference). Chapter 6: Effects of Prior Knowledge.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	73.33	10	7.33		
group	4.91	1	4.91	.67	ns
Within subjects + residual	9.70	10	.97		
text familiarity	8.84	1	8.84	9.11	.013
group x text familiarity	.05	1	.05	.06	ns
Within subjects + residual	29.98	20	1.50		
type of question	10.89	2	5.44	3.63	.045
group x type of question	2.10	2	1.05	.70	ns
Within subjects + residual	32.86	20	1.64		
text familiarity x type of question	10.80	2	5.40	3.29	.058
group x text fam x type of question	7.58	2	3.79	2.31	ns

Table A6.10 Analysis of variance of **correct answers to prior knowledge, textbase and inference questions for FAMILIAR TEXTS ONLY.** With between subjects factor of **group** (good vs. poor learners identified by exam performance); and main effect of type of question (prior knowledge vs. textbase vs. inference). Chapter 6: Effects of Prior Knowledge.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	53.69	10	5.37		
group	3.00	1	3.00	.56	ns
Within subjects + residual	37.40	20	1.87		
type of question	.09	2	.04	.02	ns
group x type of question	1.23	2	.61	.33	ns

Table A6.11 Analysis of variance of **correct answers to prior knowledge, textbase and inference questions for UNFAMILIAR TEXTS ONLY.** With between subjects factor of **group** (good vs. poor learners identified by exam performance); and main effect of type of question (prior knowledge vs. textbase vs. inference). Chapter 6: Effects of Prior Knowledge.

Source	Sum of Squares	d.f.	Mean Squares	F	p
Within subjects + residual	29.35	10	2.93		
group	1.96	1	1.96	.67	ns
Within subjects + residual	25.44	20	1.27		
type of question	21.60	2	10.80	8.49	.002
group x type of question	8.45	2	4.23	3.32	.05

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